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FUSELET AUTHORING, EXECUTION, AND MANAGEMENT IN SUPPORT OF GLOBAL STRIKE OPERATIONS

Lockheed Martin ATL

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14. ABSTRACT

Fuselets are the result of AFRL/IF Joint Battlespace Infosphere (JBI) research based on the 1998 Air Force Science Advisory Board (SAB) report, "Information Management to Support the Warrior." A fuselet is a configurable, reusable transformation component, designed to enable shared business processes across organizational and community of interest boundaries. Fuselets enable innovative workflows to meet the information transformation needs that aren't addressed by individual C2 applications. The fuselet concept thrives in environments where information objects with formatted metadata are published and can be subscribed to. Examples of such environments include the JBI, RSS feeds on the World Wide Web, and web services in a Service Oriented Architecture. In this effort we achieved our goal of developing an application demonstration of fuselet technology as applied to Global Strike operations. Following several knowledge acquisition sessions with personnel affiliated with USSTRATCOM and the USAF Air Combat Command, we developed a number of operationally relevant fuselet workflows. These SMEs provided useful feedback and assessment of the applicability of the fuselet concept. Many of the SMEs agreed that the fuselet concept has the potential to improve command and control processes in the Global Strike or Air Operations Center domains.

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1 Executive Summary

1.1 Introduction

Fuselets are the result of Air Force Research Laboratory (AFRL) Information Directorate Joint Battlespace Infosphere (JBI) research based on the 1998 Air Force Science Advisory Board (SAB) report, "Information Management to Support the Warrior."[1] A fuselet is a configurable, reusable transformation component, designed to enable shared business processes across organizational and community of interest boundaries. Fuselets enable innovative workflows to meet the information transformation needs that aren't addressed by individual Command and Control (C2) applications. The fuselet concept thrives in environments where information objects with formatted metadata are published and can be subscribed to. Examples of such environments include the JBI, RSS feeds on the World Wide Web, and web services in a Service Oriented Architecture (SOA).

1.2 Goal and Objectives

The goal of this effort was to develop an application demonstration of fuselet technology in the domain of Global Strike operations. The objectives of the effort were three-fold. The first objective was to achieve operational realism in scenario development, CONOPS development, and data acquisition/integration. The second objective was to develop fuselets and improve on the existing fuselet runtime environment. The third objective was to assess fuselet operational capability through demonstration and experimentation.

1.3 Results

In this effort we achieved our goal of developing an application demonstration of fuselet technology as applied to Global Strike operations. Following several knowledge acquisition sessions with personnel affiliated with United States Strategic Command (USSTRATCOM) and the United States Air Force (USAF) Air Combat Command (ACC), we developed a number of operationally relevant fuselet workflows. These workflows were demonstrated at the ACC Warfighter Analysis of Innovative Technologies and Concepts (WAITnC) and at a meeting with representatives of the USSTRATCOM Joint Force Component Command for Global Strike and Integration (JFCC GS&I). These Subject Matter Experts (SMEs) provided useful feedback and assessment of the applicability of the fuselet concept. Many of the SMEs agreed that the fuselet concept has the potential to improve command and control processes in the Global Strike or Air Operations Center domains. Finally, some of the results from the effort were published in a paper[2] at the Collaborative Technology Symposium 2008 to an audience of government, industry, and academic researchers.

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[1] http://handle.dtic.mil/100.2/ADA412936

[2] Chen, D.H. and Haglich, P.P. (2008). Fuselets and Collaboration for Warfighter Decision Superiority. In *Proceedings of the 2008 International Symposium on Collaborative Technologies and Systems* (May 19-23, 2008 in Irvine, CA). IEEE, 166-173.

2 Technical Background

2.1 Fuselets

Fuselets are the result of AFRL/RI Joint Battlespace Infosphere (JBI) research based on the 1998 Air Force Science Advisory Board (SAB) report, "Information Management to Support the Warrior."[3] A fuselet is a configurable, reusable transformation component, designed to enable shared business processes across organizational and community of interest boundaries. A transformation component means a simple, general purpose function for transforming data from one information format to another (for interoperability between users and tools) or for aggregating, correlating, and filtering data or generating alerts. Fuselets can be implemented in a variety of languages such as Java, Extensible Stylesheet Language Transformations (XSLT), Groovy, and Jython. A primary benefit of fuselets is to lend agility to business processes. Fuselets provide a transformation capability that is reliable, repeatable, scalable, measurable and manageable.

By creating transformations from reusable, parameterizable components rather than ad-hoc scripts, transformation logic is much less likely to contain errors. By running transformations in a managed container, problems with ongoing transformations are much more likely to be detected via logging and alerting features and therefore to be corrected in a timely fashion. Not only can fuselets be created from reusable components, but fuselets themselves provide "reusable" information insofar as their outputs are delivered via publication, allowing many information consumers, including other fuselets, to concurrently utilize the results of a fuselet transformation. This reuse of logic and results makes for much more repeatable information production than that of many clients each creating their own custom, one-time transformations.

Many transformations will be useful to many information consumers simultaneously. By running shared transformation components, significant savings in both computational and communications resources are possible, allowing both lower utilization and higher numbers of transformations. Running transformation components in a container allows us to measure the runtime performance characteristics of fuselets and populations of fuselets and also to measure and log aspects of the results of their transformations, for further analysis and refinement of the transformation logic.

A managed container also allows us to control the operation of transformations both in an aggregate and in a fine-grained manner. Malicious or malfunctioning fuselets can be limited or shutdown with both automated and manual mechanisms. Furthermore, by running fuselets within an overall information management environment, organizational and system policies can be applied to fuselets, including security, configuration, and prioritization policies.

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[3] http://handle.dtic.mil/100.2/ADA412936

Fuselets can play several roles in missile defense operations. They are excellent for monitoring indicators and warnings. Because fuselets can be implemented and deployed so quickly, new monitoring algorithms can be effectively deployed on the fly. Fuselets can also monitor sensor health using a variety of rolled-up summaries. Additionally, fuselets can be effective tools for consequence mitigation. Consider the follow question: "How do MDA, STRATCOM, 7AF, etc. exchange data when their tool sets vary and change all the time? What about non-DoD organizations?" Fuselets can be quickly and easily developed to meet these data conversion needs. By deploying fuselets to transform this data, conversions between systems can be done automatically, getting information immediately into the hands of those that need it.

Fuselet technology makes collaboration more extensible. Processes can be effortlessly adapted to accommodate new participants. Suppose that two organizations have established a collaborative process. How can a third organization be added to the process when it has its own information formats and releasability level different than those of the two current organizations? Consider this situation: USSTRATCOM and United States Pacific Command (USPACOM) have already established a process for collaborating on a Global Strike mission. Late in the planning process an allied nation joins the coalition and permits overflight. How do we bring this nation into the process when they have yet another information format and can only have a subset of the information released to them? A new fuselet can be created to transform plans to the third format while and existing filter fuselet can be configured to provide the allied nation the appropriate information.

The lifecycle of a fuselet is depicted in Figure 1.

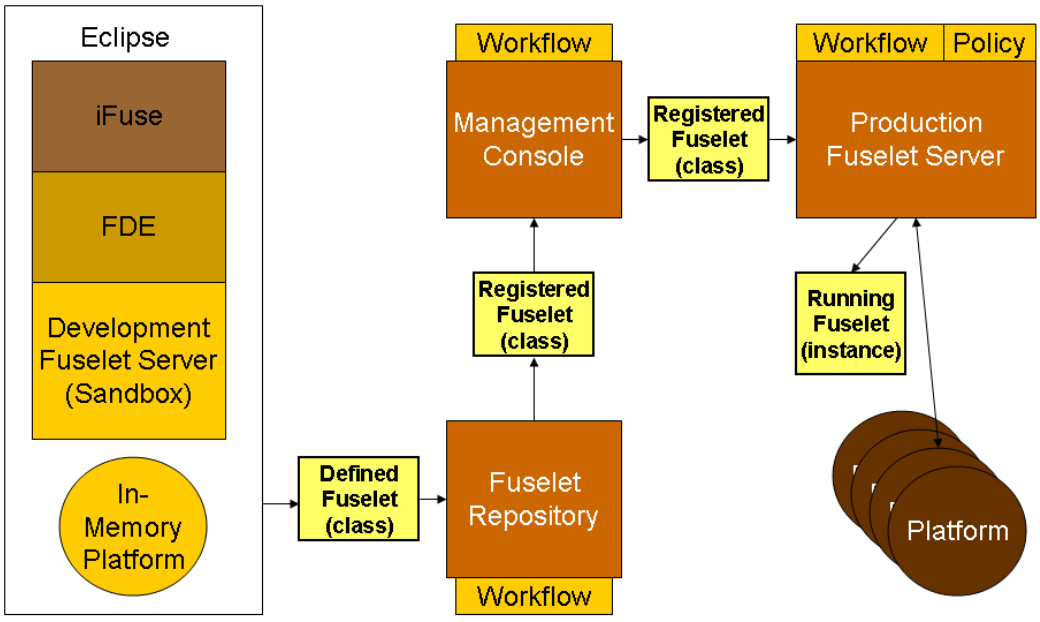

Figure 1: The Lifecycle of a Fuselet in FREeME

2.2 FREeME Description

The Fuselet Runtime Execution and Management Environment (FREeME) is a Fuselet Container: a managed service for running fuselets. FREeME is deployable to any Java 2 Platform, Enterprise Edition (J2EE) server, but is tested regularly on the JBoss Application Server (AS) version 4.0.4.GA. FREeME has the ability to process fuselets packaged in a variety of formats (individual files, JARs, etc…). An important idea to keep in mind is that FREeME and fuselets do not, in themselves, make new types of transformations, assembly of services, or shared business processes possible – instead they make enabling these things faster and more reliable. However, the resulting agility can in fact enable share business processes across organizational boundaries where before the attempt would likely be abandoned as the situation changes faster than the processes can be established.

2.2.1 FREeME Features

- Plug-in support for a variety of scripting languages
- Plug-in support for connections to a variety of information management platforms
- Web-based administration console
- Fuselet library to store predefined transformation components
- Real-time instrumentation event streams for monitoring and analysis
- Standards-compliant management features such as Log4j logging and Java Management Extensions (JMX) management
- Dynamic policy-based access control and management

The main components of FREeME's architecture and the fuselet lifecycle can be seen in Figures 2 and 3, respectively.

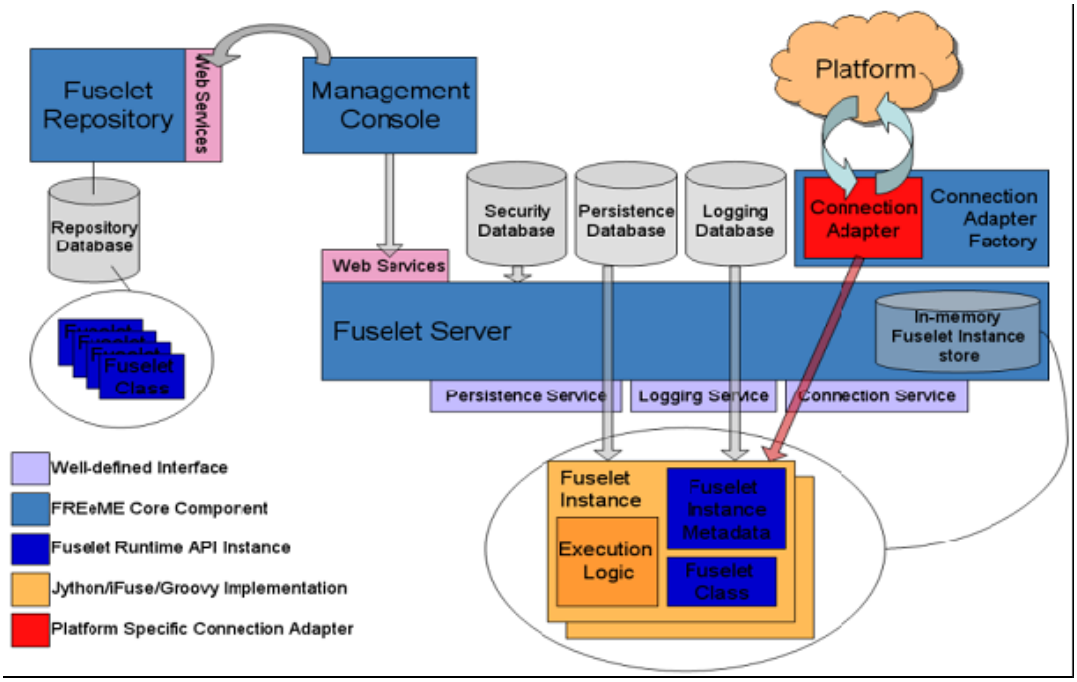

Figure 2: FREeME Architecture

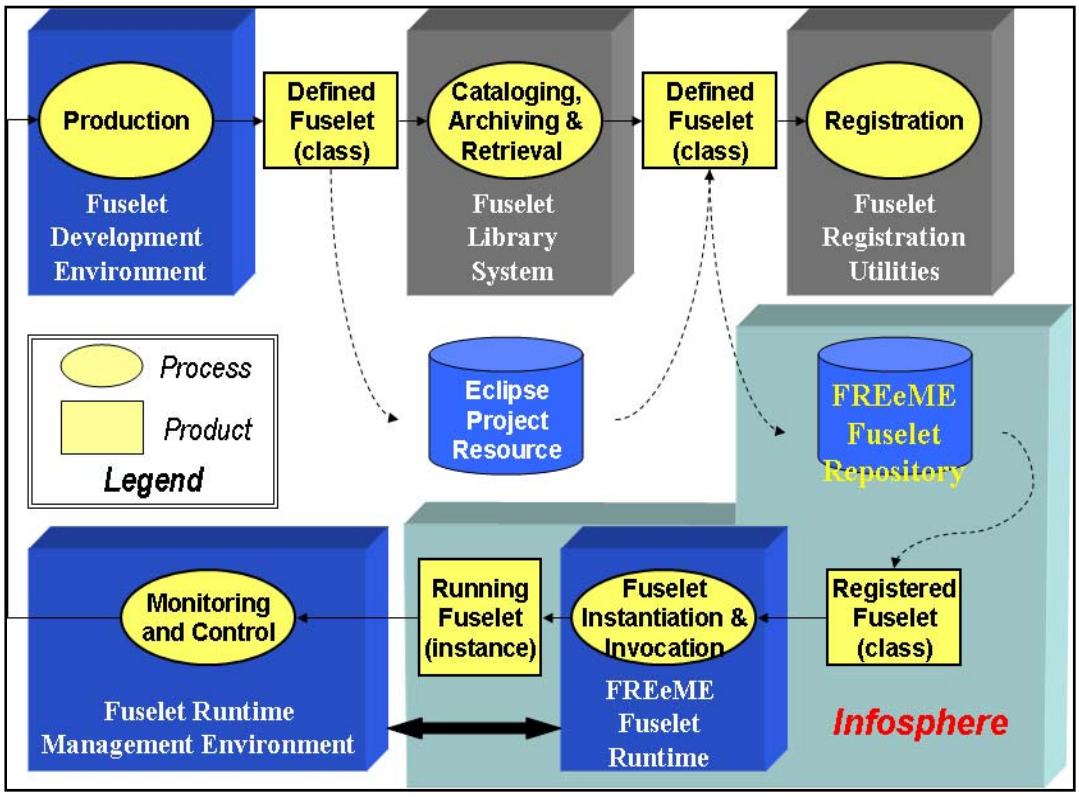

Figure 3: General Fuselet Lifecycle

2.2.2 Server

The primary function of the server component is to provide an in-memory fuselet instance store in addition to containing the implementation for the fuselet runtime environment. Language plug-ins are also managed by the server component. Whenever a fuselet is run, its execution is contained within the server. When a fuselet class is instantiated, it is immediately stored in the server's fuselet instance store. The server has a persistence mechanism that allows for fuselet instances to remain loaded after a restart/shut down. This is implemented using an HSQLDB database configured to run in in-process mode. HSQLDB is a Structured Query Language (SQL) relational database engine written in Java. It has a Java Database Connectivity (JDBC) driver and supports a rich subset of ANSI-92 SQL (BNF tree format) plus SQL 99 and 2003 enhancements. It offers a small (less than 100k in one version for applets), fast database engine that offers both in-memory and disk-based tables and supports embedded and server modes. The server maps its data to HSQLDB using Hibernate. Hibernate is an object/relational persistence and query service. Hibernate lets you develop persistent classes following object-oriented idiom - including association, inheritance, polymorphism, composition, and collections.

The server contains a list of loggers that can connect to any logging source. The FREeME logger can be viewed using a log4j viewer such as Lumbermill or Chainsaw.

Figure 4 shows Lumbermill displaying log messages from FREeME.

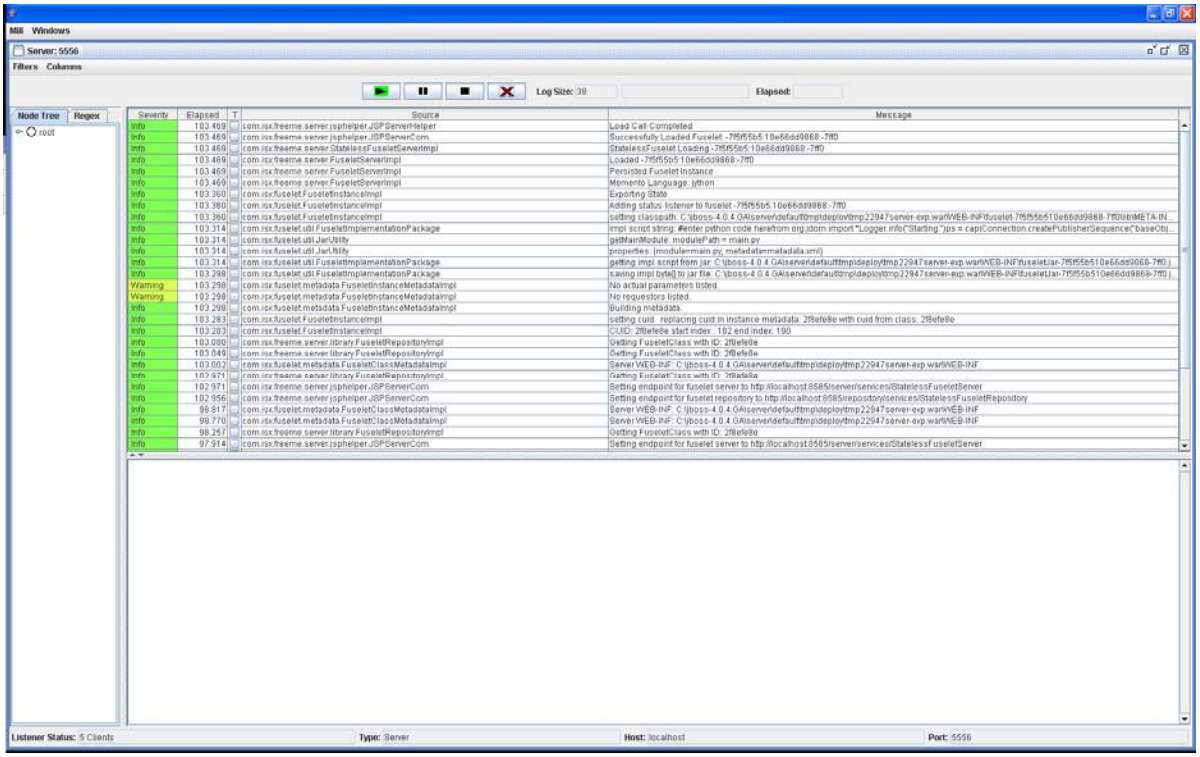

Figure 4: Lumbermill Logs of FREeME Output

2.2.3 Repository

The fuselet repository is responsible for persisting fuselet classes. Fuselets must be loaded into the repository before they can be instantiated as fuselet instances. The repository uses eXist as its persistence mechanism. eXist is an Open Source native eXtensible Markup Language (XML) database featuring efficient, index-based XQuery processing, automatic indexing, extensions for full-text search, XUpdate support, XQuery update extensions and tight integration with existing XML development tools.

2.2.4 Connection Adapter Factory

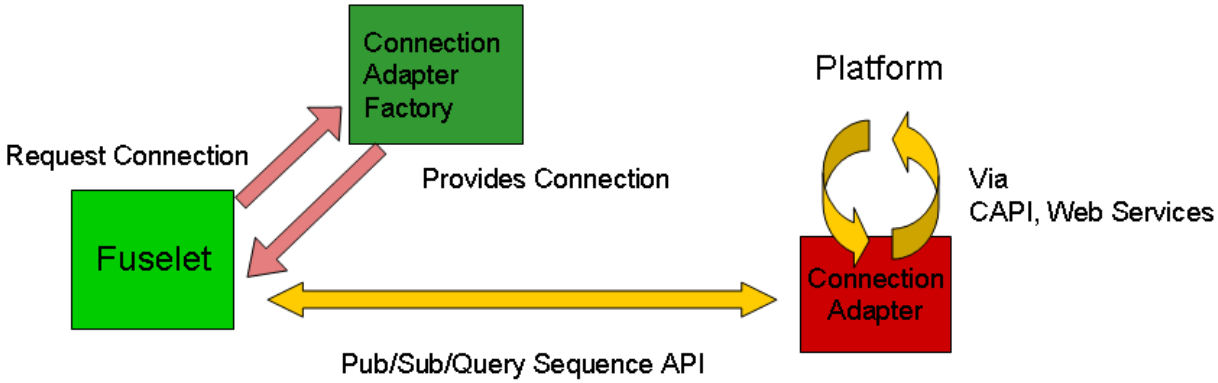

Figure 5: Connection Adapter Factory

The purpose of the Connection Adapter Factory, depicted in Figure 5, is to achieve platform and infosphere independence. The factory is instantiated and provided by the fuselet server. When a fuselet is loaded, FREeME examines the connection parameters in the class metadata, and the factory creates the appropriate connection. The type of connection object returned will correspond to the interface specified in the metadata. By only requiring a developer to be mindful of the adapter interface names, platform interoperability can be achieved with minimal effort. The developer does not need to know the details of how the adapter works; its function is transparent to the fuselet developer. Additionally, new fuselet connection adapters can be easily added to FREeME as they become necessary to accommodate additional platforms.

2.2.5 Web Console

The FREeME web console allows a user to manage both the server and the repository (see Figure 6). The management console is implemented using Java Server Pages (JSP's). Both the server and the repository make their contents available through the web console. Additionally, both the server and the repository provide you with the ability to edit the fuselet implementation or appropriate metadata. The web console also provides features for searching both the repository and the server. The console is compatible with Microsoft Internet Explorer and Mozilla Firefox.

When creating a fuselet instance from the web console, a user can either upload a file containing the instance metadata, or have the console dynamically generate the metadata. The console will display a human readable summary of a fuselet's metadata in both the repository and server views.

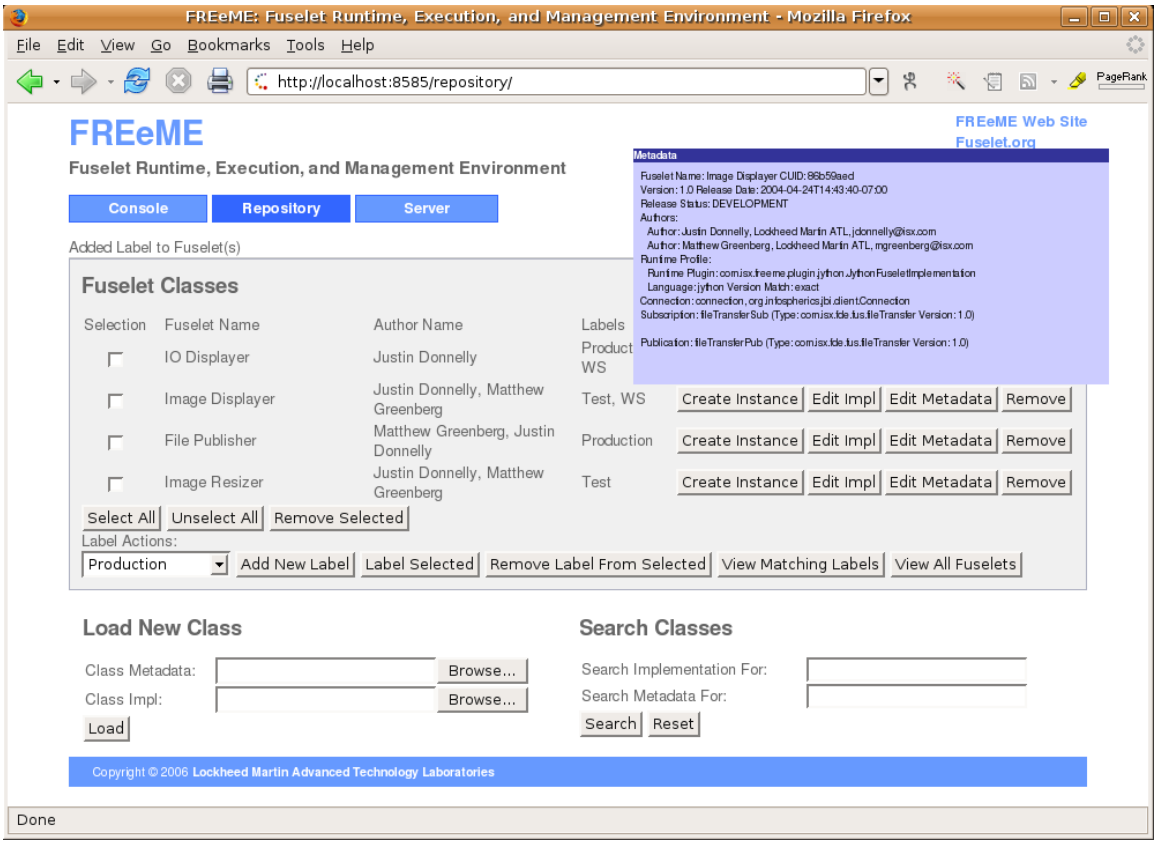

Figure 6: FREeME Web Console

2.2.6 Instrumentation

The instrumentation component of FREeME is responsible for event notification and handling. Instrumentation is essential for the publication/subscription architecture of fuselets in addition to serving as a useful tool for monitoring and analysis. Without this crucial component, fuselets would have no way of detecting the publication of new information objects. A block diagram of the Instrumentation architecture follows:

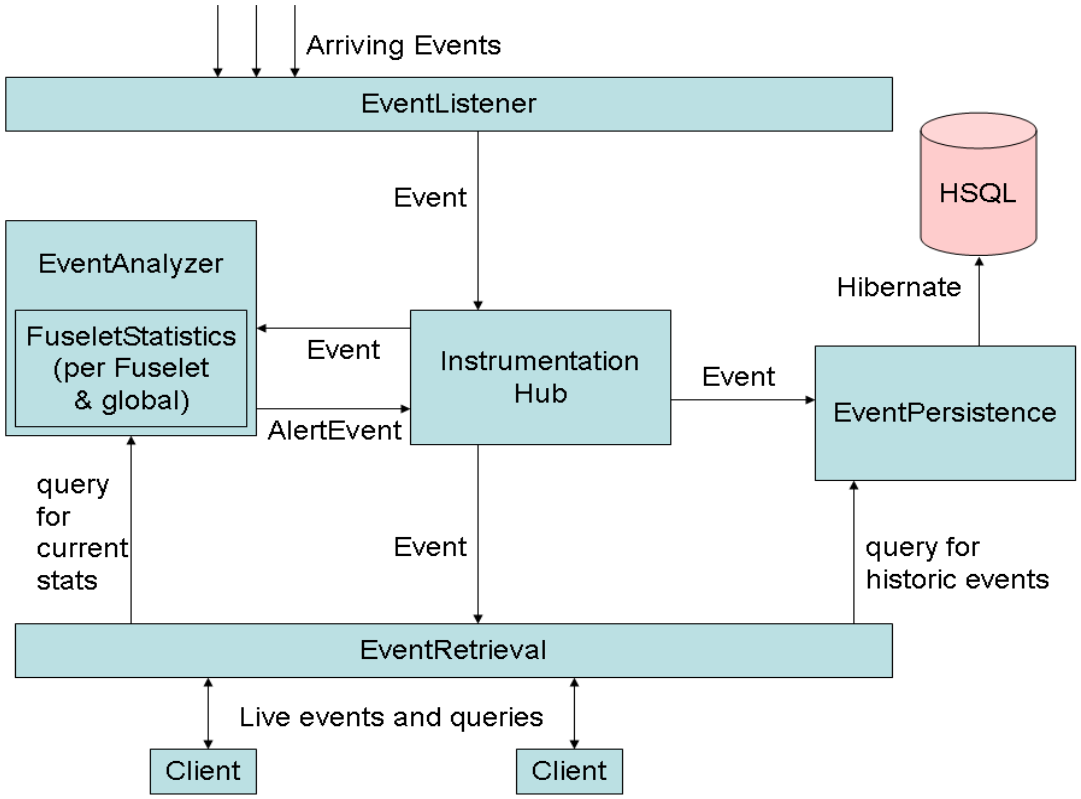

Figure 7: FREeME Event Flow

Events arriving from fuselets are intercepted by an event listener. An event analyzer then records the appropriate information about the event and sends out an alert event. Clients retrieve events from the instrumentation component through the event retrieval piece. Subscriptions and queries access the instrumentation component here. Events are persisted by the instrumentation component by writing them to an HSQL database. Objects are mapped to this database using Hibernate. Clients have the ability to query this database for recorded events.

2.2.7 ISX In-Memory Platform

The ISX In-Memory Platform (IMP) is a lightweight, JBI Common Application Programming Interface (CAPI) compliant publish and subscribe service designed to support experimentation with information management operations. It provides no long-term persistence of published information, but has no dependencies on external databases or services, can be rapidly set up, and can easily be modified or embedded in other environments.

Today, FREeME developers use it, where its ease of use allows them to focus on the development of the fuselet services. The IMP is especially advantageous for testing and prototyping fuselets. For example, the Integrated Fuselet Synthesis Environment (iFUSE) Interactive Development Environment (IDE) from ATC-NY leverages the use of

FREeME's IMP when running and debugging fuselets. The convenience of the IMP allows for significantly faster development time and reduced testing time. Lockheed ATL's Simulation Sequencer, which is included in iFUSE, can also publish and subscribe to FREeME's IMP.

2.2.8 INTERACT

In many of our fuselet application demonstrations, we used the INTelligent Environment for Real-time, Adaptive, Collaborative Technology (INTERACT) as a means of displaying the results. INTERACT is a net-centric fully distributed software framework for collaborative systems developed by Lockheed Martin ATL which provides a scalable, reliable, and secure platform for clients to communicate. The system consists of three components: a front end Graphical User Interface (GUI) for interaction with the user, a back end client which the front end or other INTERACT clients communicate with to access and modify data, and a back end server which serves as a backbone to connect all INTERACT clients collaboratively.

INTERACT provides the capability to synchronize information across multiple clients in disparate locations over networks of variable bandwidth, latency, and reliability. The system also provides a pluggable layer of services for openness and optimization, and is designed for robust performance even after the loss of one or more clients or servers.

The INTERACT GUI provides icon and drawing pallet components as well as a map and table viewer where users can collaboratively share and view data and highlight items and areas of interest. These components allows users to hold live, near-synchronous collaboration sessions combining drawing gestures and data manipulation on shared information products, augmented with Voice Over IP (VOIP) speech. These shared products can include data feeds provided by other command and control information systems via web services. Users can combine and link information products to build, share, and brief more complex models of problems they are working. This aids military commanders and their command staff, where although they may be in disparate locations, they can work together to formulate a battlespace visualization using maps, tables, and timelines to build a mutual understanding of a military scenario or situation, share insight, and collaboratively come to a decision on the next action or step to take. Additionally, INTERACT allows collaborators to separately visualize the scenario from their understanding and point of view and to share and collaboratively discuss their visualization with their counterparts.

3 Global Strike Relevant Fuselets and Workflows

A major emphasis of the effort was to develop operationally relevant fuselets. In this chapter we describe some of these projects and their operational relevance. We focus here primarily on fuselet workflows, which are compositions of information objects and fuselets to produce aggregated or abstracted information objects from multiple sources. Details of the individual fuselets can be found in Appendix A: Fuselet.

3.1 Fuselet Workflows

The real power of fuselets is realized when they are composed into workflows to produce information products. To that end we focused on developing fuselet workflows to meet operational needs for Global Strike operations. In our knowledge acquisition sessions we presented these workflows to our subject matter experts for review and discussion. In this section we describe the fuselet workflows that we implemented or defined. Each workflow is described using a concept map[4]. Rounded rectangles, or nodes of the concept map, represent information objects. Some of these information objects are inputs from other information sources, while some are intermediate products of the workflow. The links in the concept map represent fuselet transformations.

3.1.1 Implemented Workflows

Geo-Associated Data Retrieval

This workflow retrieves a variety of information associated with a geographic location. It is depicted in Figure 8.

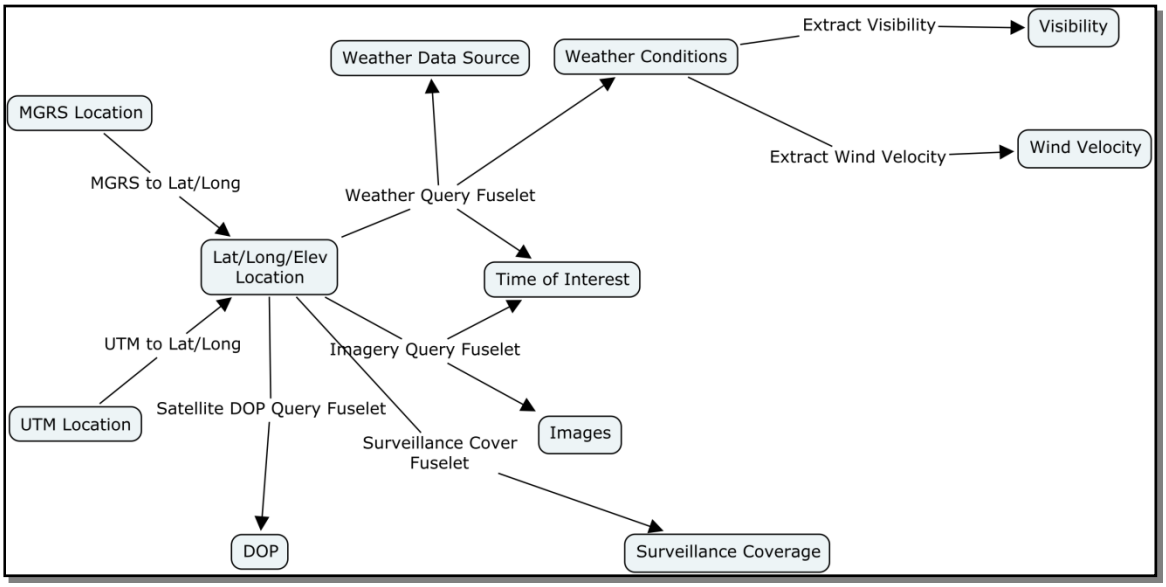

Figure 8: Workflow for Geo-Associated Data Retrieval

The initiator for this workflow is a geographic location, which could be supplied in one of several coordinate systems: latitude/longitude/elevation, Universal Transverse Mercator, or Military Grid Reference. Coordinate conversion fuselets produce a location described in latitude/longitude/elevation coordinates. This location is used by several fuselets to query data sources for weather reports, navigation accuracy (dilution of precision, or "DOP"), imagery, or surveillance coverage. An additional parameter is the time of interest, which defaults to the current time. The workflow has several outputs. The weather query fuselet returns the weather conditions for the point of interest at the time of interest. Additional fuselets can extract individual parameters such as the

[4] http://en.wikipedia.org/wiki/Concept_map

visibility and wind velocity. The DOP query returns the value for the DOP at that point. The imagery query fuselet produces a set of images of that point. The surveillance cover fuselet provides a set of assets that can provide coverage of that location.

Targets and Entities to Plot

This workflow produces a set of targets or other entities to plot, as shown in Figure 9.

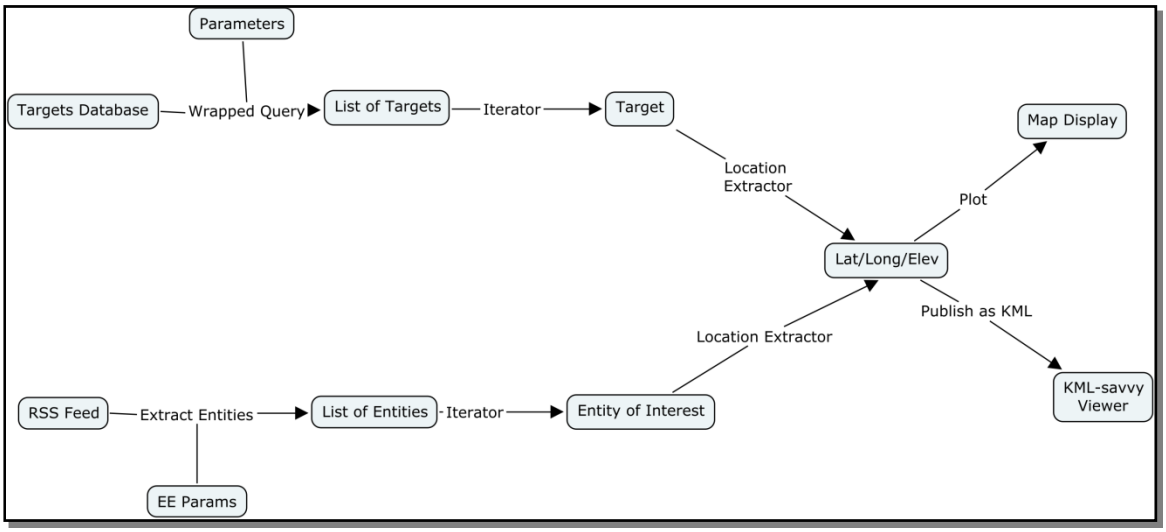

Figure 9: Workflow to Provide Entities to Plot

There are two alternative methods for initiating this workflow. The more traditional way is to provide a set of categorical or geographic criteria for the query. An alternative way is to use entity extraction software such as Inxight Thingfinder or Lockheed Martin AeroText to extract references to entities of interest from text. In the diagram we show this text being served via an RSS feed. Regardless of which input path is taken, location extractor fuselets extract geographic coordinates. The collection of relevant objects can then be plotted to a map display such as the OpenMap in INTERACT. Alternatively, they can be published in the Keyhole Markup Language (KML) format used by Google Earth.

Collateral Damage Risks

This workflow identifies potential collateral damage risks associated with proximity to a target of interest. The workflow is shown in Figure 10.

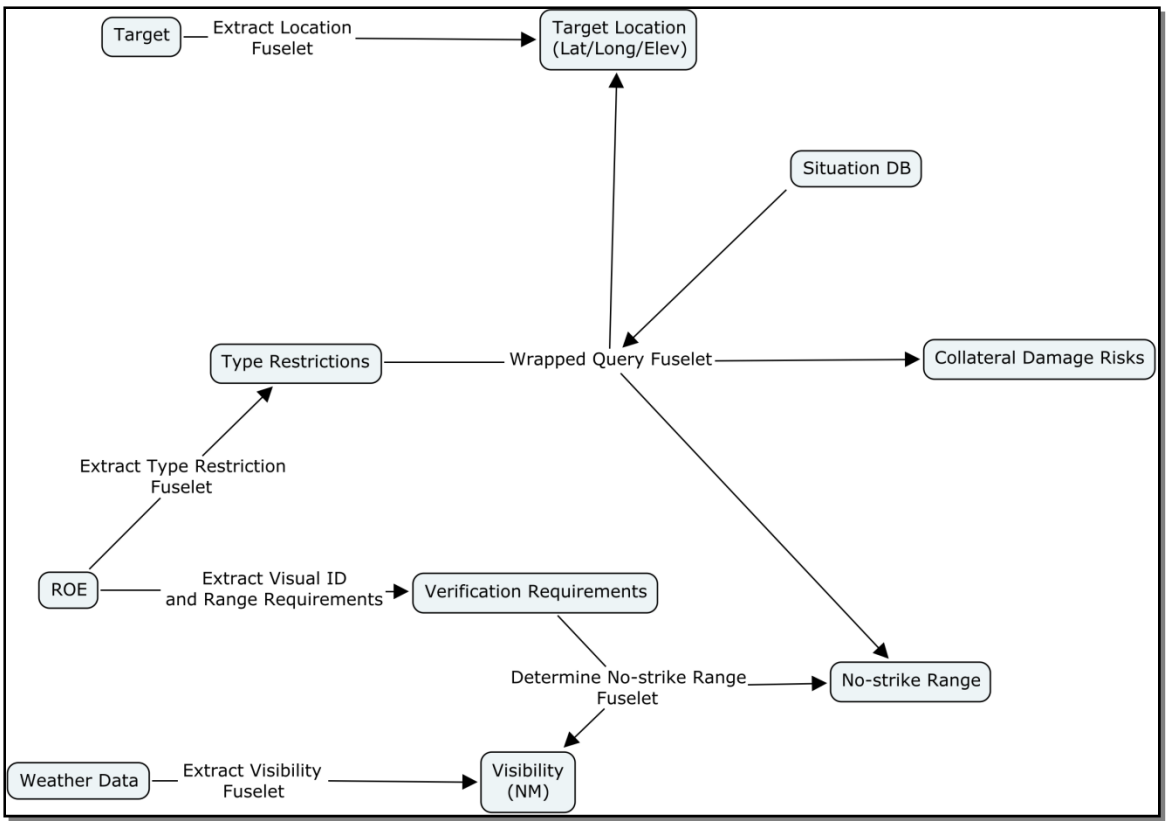

Figure 10: Workflow for Collateral Damage Risks

There is a basic workflow and a more sophisticated workflow. In the simplest path, a target is provided as an initiator. The location of the target is extracted and used by a fuselet that queries for restricted and no-strike targets within a given range of the target. The result is a collection of collateral damage problems which can be plotted on a map.

A greater degree of sophistication is provided when a branch to this workflow is added to parse the rules of engagement (ROE) in force. This could be done using an entity extractor as described above. In this branch the wrapped entity extractors determine categorical restrictions and proximity requirements based on visual identification requirements and weather conditions. The result provides range and category parameters to be used by the basic workflow. We did not implement this branch save for the part that extracts the visibility at the target location based on weather conditions.

DISUM Parsing

During operations or exercises it is common for the Intelligence Division to produce Daily Intelligence Summary (DISUM) messages. We designed a fuselet workflow to monitor these messages and build a summary of the intelligence citations for each target. This workflow is shown in Figure 11.

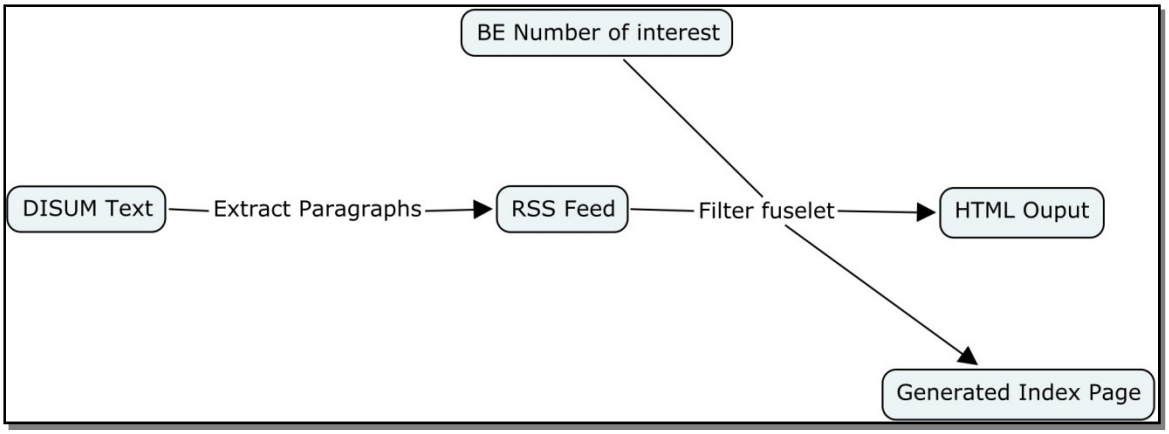

Figure 11: DISUM Parsing Workflow

First, the DISUM text is disaggregated into paragraphs and republished as an RSS feed. Filter fuselets act on the items in the feed to detect references to target Basic Encyclopedia (BE) numbers. For each BE number a summary page is built in Hypertext Markup Language (HTML). This web page contains all paragraphs that cite that target. Additionally, an index page is built that includes links to the summary pages for each target.

Populated Places within Range

An additional collateral damage consideration when attacking a facility that contains radiological, bacteriological, or chemical substances is the danger to the nearby populace. The workflow to determine the populated places at risk is shown in Figure 12.

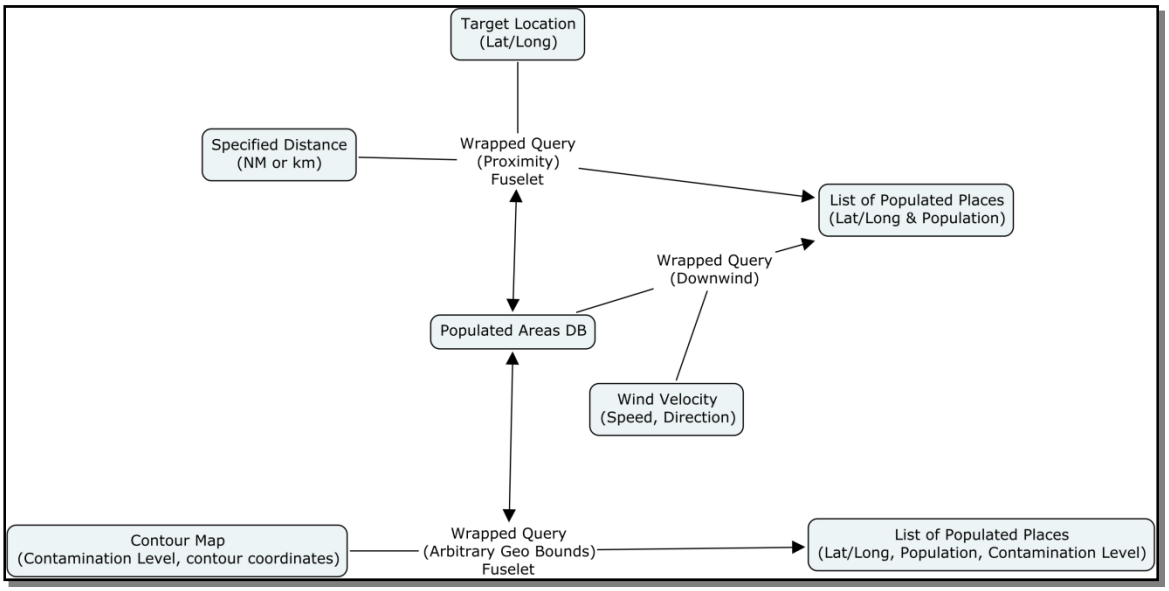

Figure 12: Populated Places within Range Workflow

There are several alternative paths through this workflow. The simplest path checks for populated places within a specified range of the point of interest. This is the path that we implemented. An advanced alternative accounts for wind velocity to

determine a list of populated places downwind of the point of interest. Another advanced alternative uses a contour plot of the contamination levels to determine which populated places are critically contaminated.

Consequence Mitigation

This workflow is similar to the previous workflow, but from a defensive point of view. It is shown in 13.

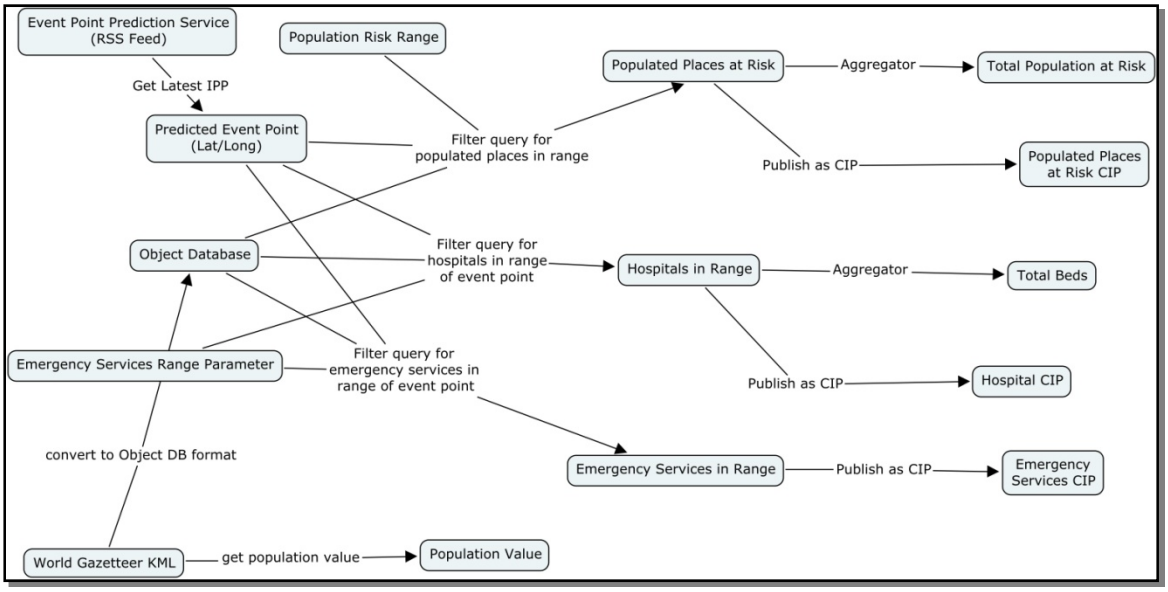

Figure 13: Consequence Mitigation Workflow

Here we consider a potential missile impact or natural disaster predicted at a point. Based on the predicted event point we query our situation knowledge base for the collections of populated places, hospitals, and emergency service facilities in range. These collections can be published as INTERACT Critical Infrastructure Protection (CIP) information. Using the results, aggregation fuselets determine the total populace at risk and the number of available hospital beds.

In our implementation of this fuselet workflow we examined a potential impact point in the vicinity of Anchorage, Alaska. We used the World Gazetteer[5] to obtain a KML file with populated place names, locations, and populations. These were converted to INTERACT objects and made available in the INTERACT database. Using open source data on the Internet we also built KML files listing the nearby hospitals and emergency services, along with bed counts. These were converted to the INTERACT DB as well.

[5] http://world-gazetteer.com/

EBO Dependencies

This fuselet workflow explored the use of dependencies as modeled in the Integrated Strategic Planning and Analysis Network (ISPAN) Node Ontology[6] for effects based operations. The workflow is depicted in 14.

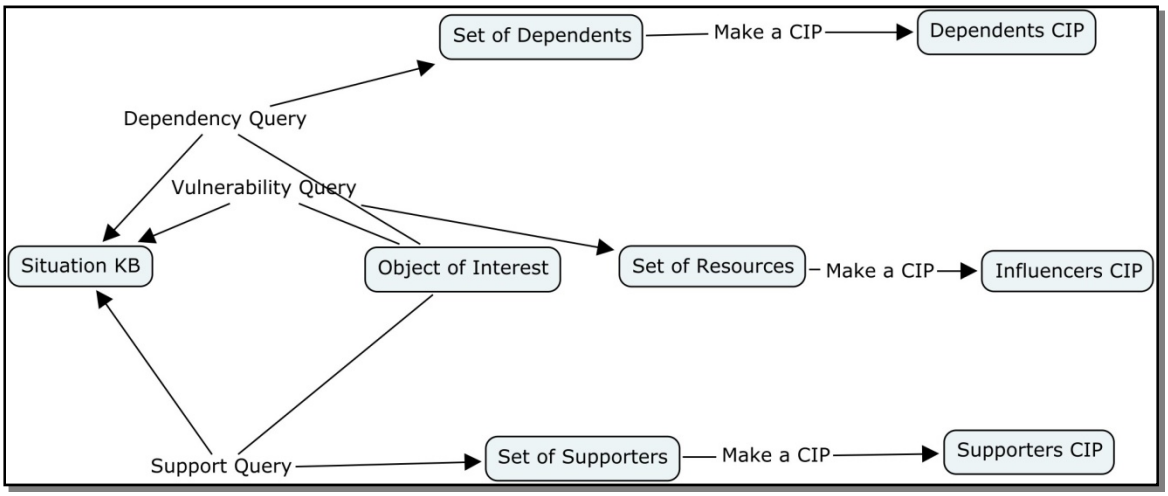

Figure 14: EBO Dependencies Workflow

In this workflow, the situation knowledgebase is a Sesame[7] Knowledge Base (KB) and is organized according to the Node Ontology. Given a node of interest, fuselets issue queries against the KB using its query language to determine the other nodes that are either dependent on the focus node support the focus node. Another query retrieves friendly resources capable of exploiting the vulnerabilities of the focus node directly. The results of the three queries are published as INTERACT CIPs.

3.1.2 Designed Workflows

The following fuselet workflows were designed and briefed to subject matter experts. However, they were not implemented due to resource constraints.

Build Prioritized Target List

This fuselet workflow arbitrates target nominations from multiple sources in order to develop a composite target prioritization list. The workflow is shown in Figure 15.

[6] ISPAN is a major command and control program for USSTRATCOM. A small portion of this program was focused on the development of a prototype system for Effects Based Planning. Under this prototype Lockheed Martin developed a nodal analysis model that uses the notions of dependency, capability, and vulnerability. This model is expressed in the Node Ontology.

[7] http://openrdf.org/

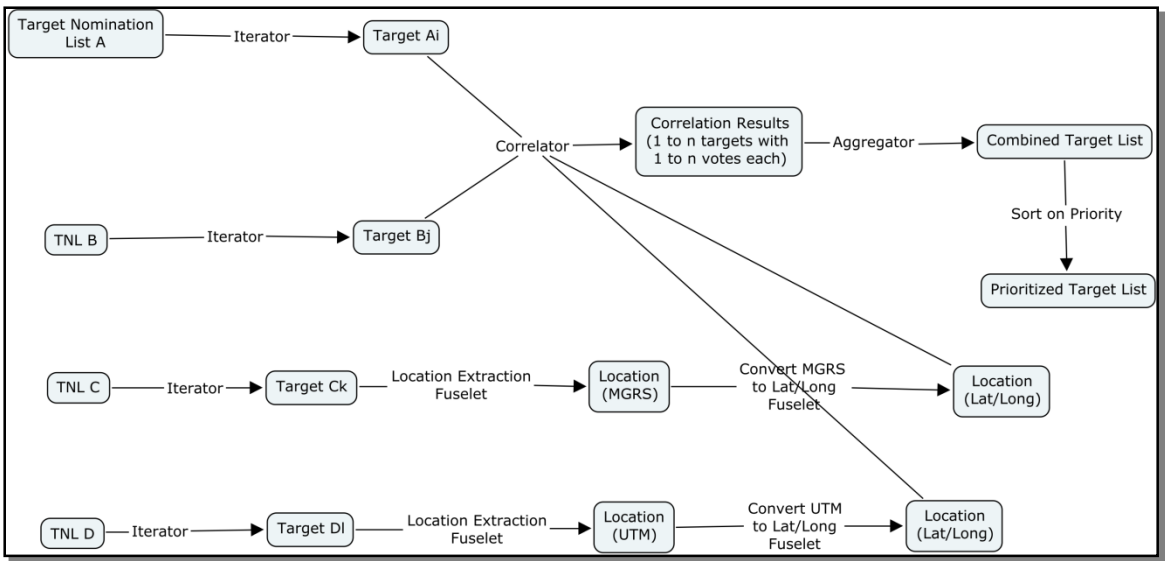

Figure 15: Build Prioritized Target List Workflow

As depicted, the workflow features Target Nomination Lists (TNLs) C and D that use alternative coordinate systems for target locations. Conversion fuselets map these to latitude longitude references. A correlator fuselet examines the target descriptions to reconcile which refer to the same targets. The correlation results are then aggregated and sorted to produce the prioritized list.

Level at Location

This workflow uses a contour map and location reference to determine the level at a given point. This workflow is shown in Figure 16.

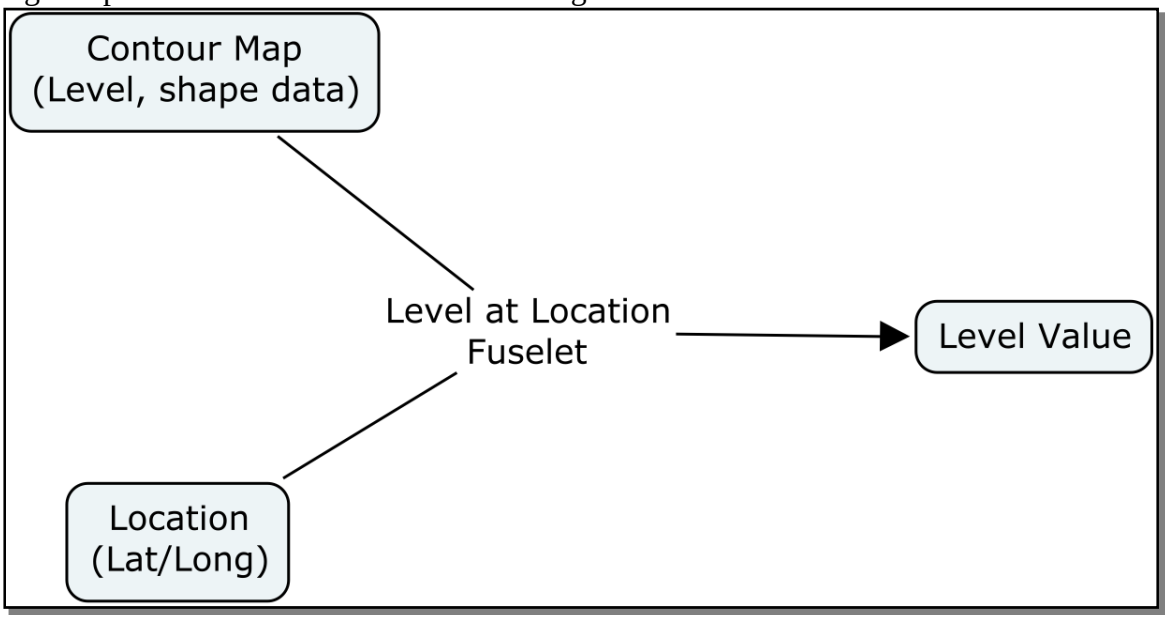

Figure 16: Level at Location Workflow

Elements of this workflow were shown in the "Populated Places within Range" workflow.

Build Plume

The purpose of this workflow is to wrap a call to a plume model service such as the Environmental Protection Agency (EPA) Areal Location of Hazardous Atmospheres (ALOHA) model.[8] The workflow is shown in Figure 17.

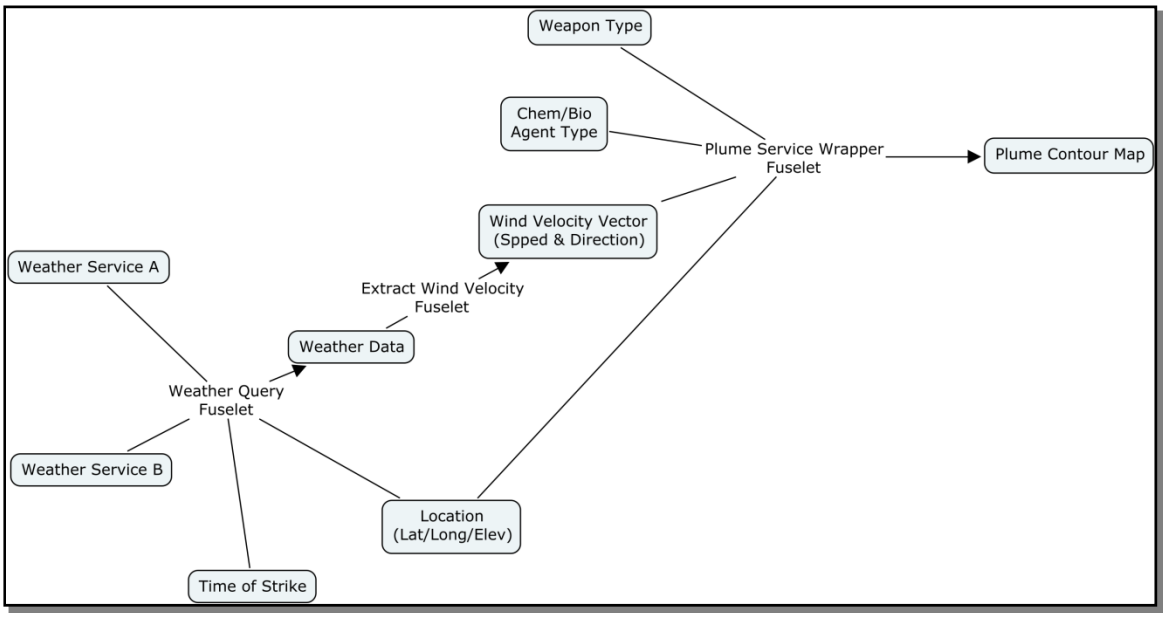

Figure 17: Plume Contour Map Workflow

This fuselet uses the location of the target and a time of interest to retrieve wind and weather data. The nature of the target (type of contaminant and amount, type of structure) and the weapon is used to call the plume service to obtain a contour map of contaminant levels from the plume. This contour map could then be used as an input to a workflow such as the "Level at Location" workflow.

4 Seminar and Experiment Results

During the effort we conducted several seminars and experiments with subject matter experts in Global Strike and Air Operations Center operations. These SMEs are mainly associated with the USSTRATCOM and ACC. Summaries of these events are shown below.

4.1 Warfighter Workshop June 2007

Lockheed Martin ATL and Teledyne Brown CollaborX conducted a half-day session with eight invited SMEs in the vicinity of Langley Air Force Base in Hampton, VA on June 7th. At this meeting we presented a description of the effort and a list of the fuselet concepts that the team had developed. The SMEs provided several additional ideas and gave us useful feedback on our ideas. A survey was sent to the users asking

[8] http://www.epa.gov/emergencies/content/cameo/help/Chapter58.html#914006

them each to vote for three of the fuselet concepts. The resulting prioritized list of fuselet concepts:

- Information pedigree – who; when; how many times has that target been nominated – struck; where is the BDA etc (4 votes)
- Format Conversions – United States Message Text Format (USMTF) 2000 Format Air Tasking Order (ATO) -> USMTF 2004 Format, RSS <-> JBI Info Objects, Google Earth KML <-> Map formats (3 votes)
- Auto-weaponeering by understanding environmental affects; weapon; time; GPS; Intel weapon target pairing; best available for Probability of Kill (PK)/effects (3 votes)
- AFSTRAT 12 hr Course of Action (COA) developed and selected – status of global resources and desired weapon effects; target area environmental factors; Area of Responsibility (AOR) support asset availability. (2 votes)
- Sensor management – initial track; pass track to next sensor; alerts down the road; sensor info correlation form different sensor types; notification to defensive assets; early ID; attack profiles; Management of the entire process. (2 votes)
- Geographic Computations – Great Circle Distance, Time To Strike, Deduced Reckoning (1 vote)
- Landing of a missile in route – who needs to be notified – winds; weather; consequence mitigation (1 vote)
- Gaining AOR needs insight into AFSTRAT Planning – and vice versa (ISR STAKE; ISS-ESC) (1 vote)
- J1 – how long has people been in theater – track evaluations, awards, if they meet criteria for award sent alert; family separation; (1 vote)
- AFRL/RI Joint Airspace Management and Deconfliction (JASMAD) pass specific messages to specific users and alternate means of transmission is primary not available; feed back that information is received (assured receipt). (1 vote)

The results of this survey were used in selecting fuselet workflows for design and implementation. For example, the collateral damage workflow is related to the information pedigree fuselet concept.

Of particular interest is the "J1" fuselet concept. Most of the other fuselets and workflows deal with operational or tactical considerations. The "J1" concept looks at how fuselets could help address personnel management issues across a variety of information sources. We did not focus on this fuselet concept in the effort because it didn't really fit with the other fuselet concepts. However, it would be worthy of future consideration.

4.2 WAITnC September 2007

A major objective of the Global Strike Fuselets (henceforth referred to as "GS Fuselets") effort is to elicit feedback from experienced military operators familiar with command and control during operations similar to Global Strike operations. To that end, the GS Fuselets contractor team participated in an event sponsored by the Global Cyberspace Integration Center (GCIC), designated as Warfighter Analysis of Innovative Concepts and Technologies (WAITnC). The WAITnC event provided a good opportunity for operators to observe fuselet technology at work and to provide feedback.

We demonstrated fuselet workflows in support of two of the mission focus themes relating to Mission Analysis in the WAITnC event. One focus theme of the Mission Analysis thread was to build common situational awareness. In support of this theme we demonstrated a fuselet workflow to extract a set of targets based on categorical and geographic filter criteria. Another focus theme was to develop a Mission Statement and Commander's Intent. Under this theme we demonstrated fuselet workflows to review target locations for collateral damage and no strike restrictions. We also demonstrated a workflow to review resources for potential airfield weather restrictions.

A detailed analysis of the results of our participation in WAITnC can be found in Appendix B, originally submitted as a separate deliverable under this contract. We summarize the results here.

In the threads where we developed and demonstrated fuselet workflows (Mission Thread Events #1 and #2) many more warfighters and participants agreed with the proposition that fuselets add value to the thread than disagreed. Among responders who expressed an opinion, the breakdown of responses was as follows:

Table 1: Response Summary

Thread	Responder Group Expressing an Opinion	Agree or Strongly Agree	Neutral	Disagree or Strongly Disagree
#1	Warfighters (48)	64.6%	25.0%	10.4%
#1	Participants (137)	52.6%	18.2%	29.2%
#2	Warfighters (27)	48.1%	44.4%	7.4%
#2	Participants (51)	39.2%	45.1%	15.7%

This is encouraging for the prospects of fuselet technologies providing benefit to AOC Strategy Division operations. For example, consider the warfighter responses in thread #1. If 64.6% of the responses indicate value added by fuselet technology based on demonstration of a small set of specific fuselet workflows then the potential level of support for the fuselet value proposition should be at least this high, if not higher.

4.3 AFRL/STRATCOM Fuselets and Mashups Seminar February 2008

On 11 February 2008 representatives of AFRL's Information Directorate, USSTRATCOM's Joint Force Component Command for Global Strike and Integration (JFCC GS&I), and Lockheed Martin[9] met to discuss common interest in data transformation technologies in a net-enabled command and control environment. The purpose of the meeting was to learn about the interests and initiatives of the other

[9] The Lockheed Martin personnel included personnel working on the AFRL-funded Fuselets for Global Strike effort, developers on the USSTRATCOM ISPAN program, and engineers managing the Web Services Factory Internal Research and Development effort.

organizations. A secondary purpose was to provide AFRL and USSTRATCOM with the information they need to make a decision regarding future mutual pursuits.

As part of the seminar we demonstrated several fuselet workflows:

- Effects-Based Operations (EBO) Dependencies
- DISUM Parsing
- Targets of Interest
- Airfield Weather Problems
- Collateral Damage Warnings
- Consequence Mitigation

Participants agreed that fuselet technology is relevant to the data transformation needs of USSTRATCOM. The team was encouraged to "keep on doing what you're doing". The participants also discussed several actions that could be taken to transition this technology to USSTRATCOM. These are:

- Follow-on meetings between AFRL and USSTRATCOM, including USSTRATCOM attendance at the upcoming AFRL Operational Information Management Principal Investigators Meeting in April 2008.
- Adding fuselet capability to the ISPAN program, perhaps through an existing Contract Line Item Number (CLIN), or a new CLIN.
- Starting a series of experiments at Lockheed Martin's Global Operations Center – Experimental (GOC-X) featuring Web Services Factory (WSF) and fuselet technologies, operators from USSTRATCOM, and a sampling of the various mission areas of interest to USSTRATCOM, starting with the existing activity models and use cases.

5 Conclusion

Fuselets and INTERACT provide a collaborative framework and platform for both knowledge management and decision making support. The dynamic nature of fuselet technology and the free range of collaboration offered by INTERACT can be expanded to fit a wide range of scenarios and application domains. Based on our results and input from users, we believe that these integrated technologies can offer significant benefits to both military and non-military operations. In conclusion, we suggest that novel ways of using fuselets and INTERACT should continue to be explored to maximize the potential of this real-time collaborative system.

Appendix A: Fuselet Details

A.1 Designed Fuselet Categorizations

Listed in this section of Appendix A are the fuselets that were designed under this effort. The fuselets are categorized using 2 facets. The columns reflect the abstractness of the fuselet transformation. The columns increase in abstraction from left to right and could be considered to be an ordinal scale. The rows reflect the domain functionality nature of the fuselet. The row headings form a nominal set, with no sense of order or comparison. Fuselets listed in plain text in the table were also implemented in software. Fuselets in italics were designed but not implemented.

Group	**Format**	**Filtering**	**Aggregation**	**Abstraction**
Navigation	•Conversions among Lat/Long, UTM, MGRS (6) •Publication of points and routes to KML (2)	•*Point in Area*	•Great Circle Distance •Great Circle Dead Reckoning •Azimuth & Elevation to Satellite (2) •*Endurance Remaining* •*Nearest Point in a given direction*	•Time to Engage •*Level at Location*
Numerics			•Chatter Count •Moving Average •Moving Standard Deviation •*Weighted Average* •*Rank order*	•Trend Alert •*Rate of Change* •*Cluster Analysis*

Group	Format	Filtering	Aggregation	Abstraction
Info Retrieval		•Flight Tracker •Weather Data •Satellite DOP •*Target DB Query*	•DISUM -> RSS •Target indexing from DISUM • Target intelligence summary from DISUM citations.	•Geo-associated data for a mission (several) •Entity Extraction
Assessment			•Available Hospital Beds •Emergency Services Available •Population at Risk •*JMEM Lookup* •*Pop-Up Threats* •*Targets of Opportunity* •*SITREP Aggregation* •*COA Score* •*Surveillance at Location*	•Collateral Damage Risk • Weather Restrictions •EBO Dependencies for a Target •*COA Recommendation* •*Effects Assessment*
Image Manipulation	•Image bit depth conversion •Image size conversion		•*Imagery at Location*	•
Other	•RSS <-> JBI Info Object (2) •Webscraping		•*Plume Wrapper* •*ATO Format Translation*	•*Target Description Correlation* •*Merged Target Prioritization*

Table 2: Designed Fuselet Categorizations

A.2 Fuselet Descriptions

Listed here are descriptions of the Global Strike fuselets in terms of inputs, outputs, functionality, and complexity.

Fuselet Name	Input Description	Input Format	Data Source	Functional Description	Output Format	Complexity Factor	Parameters
Great Circle Distance	2 info objects publishing positions	Lat/Long		Uses formula for great circle distance between 2 points.	Distance in NM	Low	
Time to engage	1 target position, 1 platform position, platform speed, platform weapons range	Lat/Long, Lat/Long, Speed (kts), Range (NM)	Target - TBMCS TNL Platform: Blue Force Tracker	Compute distance between the platform and the target (using Great Circle Distance fuselet), subtract weapons range, and divide by speed.	Time in hours	Low	
GPS Accuracy at a Point	Position	Lat/Long		Performs a lookup to get the value	CEP in meters	Low	
Chatter Count	Stream of messages		SIGINT or COMINT	Counts the number of messages each hour	Messages/Hour	Low	
Moving Average	Stream of numbers		Chatter Count Fuselet	Determines the moving average of the messages/hour for the last X hours	Messages/Hour	Medium	X hours time window
Moving Standard Deviation	Stream of numbers and moving average		Chatter Count Fuselet + Moving Average Fuselet	Determines the standard deviation of the messages/hour over the last X hours.	Messages/Hour	Medium	X hours time window

Fuselet Name	Input Description	Input Format	Data Source	Functional Description	Output Format	Complexity Factor	Parameters
Trend Alert	Stream of numbers, moving average, standard deviation		Chatter Count Fuselet + Moving Average Fuselet + Moving Standard Deviation Fuselet	Alerts when the count differs from the moving average by more than A*the moving standard deviation.	Alert Signal + Direction	Medium	A - number of standard deviation multiples
Complex Alert	Collection of Trend Alert Fuselet signals	Alert Signal + Direction	Trend Alert Fuselets	Issues a detailed alert when M out of the N trend alerts are received within T time.	Alert Signal + Description		M, N number of inputs, T time window
METOC Data for a Point	Position	Lat/Long	Weather Data Source, including open-source such as Yahoo	Retrieves the weather data for a position.	Weather Data	Low	
METOC Data for a mission	Mission points of interest	Mission Route	Weather Data Source	Given the mission plan, extract coordinates for launch base, rendezvous point(s), mission objectives, recovery base, and divert bases. Return the aggregate product.	Aggregated Weather Data	Medium	

Fuselet Name	Input Description	Input Format	Data Source	Functional Description	Output Format	Complexity Factor	Parameters
Pop-Up Threat	Threat description and location	Lat/Long	MASINT or ELINT	Queries the ATO, lists missions that will fly within D distance of the point in the next H hours.	List of missions	Medium	D distance, H hours
JMEM Lookup	Target and weapon system	Target designation, munitions designation	MIDB, JMEM	Queries JMEM, returns "Yes" if the weapon can destroy the target with probability P, "No" if it cannot.	Yes/No	Medium	Probability P
Targets of Opportunity	Target locations, Platform location, platform fuel remaining, recovery base location	Lat/Longs, NM from Distance Remaining Fuselet	MIDB or TBMCS, Distance Remaining Fuselet, Great Circle Fuselet	Determine great circle distances from current position to each target (subtract weapons range) and from each target to recovery base. Test against report from Distance Remaining Fuselet	List of targets	High	
Distance Remaining	Fuel level, consumption rate, speed in kts	Lbs, Lbs/hr, Speed	Platform characteristics and fuel status	Distance = Speed * Lbs/(Lbs/Hr)	Distance in NM	Low	

Fuselet Name	Input Description	Input Format	Data Source	Functional Description	Output Format	Complexity Factor	Parameters
Strike Options Within TOT	Target position, set of platforms, Time On Target Window	Lat/Long, Lat/Long, Speed (kts), Range (NM), TOT Window Start and End	Target - TBMCS TNL? Platform: Blue Force Tracker, Time to engage Fuselet	For each platform, determine time to engage. See if it falls within the TOT window.	List of platforms	Medium	
ATO USMTF 2000 to 2004 Conversion	ATO in USMTF 2000 format	USMTF 2000 format	TBMCS	Converts the ATO from 2000 format to 2004 format.	USMTF 2004 format	Medium	
Sitrep Aggregation	Input reports	Text	RSS feed	Builds a composite situation report from the various pieces.	Formatted SITREP	Medium	
RSS to JBI	RSS feed	RSS or Atom XML format	Internet or intranet	Converts the RSS to a published stream of JBI Information Objects, probably using XSLT	JBI Information Objects	Medium	Feed URL
JBI to RSS	JBI published information objects	JBI IO	JBI	Converts JBI IOs to RSS format, probably using XSLT	RSS	Medium	IO identifier
Entity Extraction	Text	Most textual formats	JBI, Internet	Wraps entity extraction software to detect instances of people, places, weapons systems, relationships.	RDF	High	
Focused Entity Detection	Text	Most textual formats	JBI, Internet	Flags reports that pertain to a specific entity of interest.	JBI Information Objects	High	Entity of interest

Fuselet Name	Input Description	Input Format	Data Source	Functional Description	Output Format	Complexity Factor	Parameters
Webscraper	Web page	HTML	Internet or intranet	Scrapes a semi-formatted web page, converts output to XML	XML	High	Page URL, items of interest.
ATO free text extraction	ATO	USMTF	TBMCS	Passes the remarks section to an Entity Extractor Fuselet for processing	Text	Medium	
Publish Positions to Google Earth	Geographic Position Information	Lat/Long		Takes a set of positions and converts them to Google Earth's KML format (an XML format)	KML	Medium	
Publish Route to Google Earth	A route	Set of lat/long points		Takes the set of points, converts them to a route in KML format.	KML	Medium	
UTM to Lat/Long	Position	UTM coordinates		Converts position to Lat/Long	Lat/Long	Low	
Google Earth to OpenMap	Google Earth formatted geodata	KML		Converts KML to routes and positions	Lat/Long	Medium	
Time-Based Rate of Change	Numeric values	Time-tagged numbers		Takes the current value, subtracts previous value, and divides by elapsed time.	Numeric (per time unit)	Low	

Fuselet Name	Input Description	Input Format	Data Source	Functional Description	Output Format	Complexity Factor	Parameters
Flat Earth Dead Reckoning	Position and Velocity	Lat/Long, Course, Speed(kts)		Given position and velocity data and time step and duration parameters, dead reckon the platform every T seconds for D seconds. Uses a "flat Earth" model for small distances.	Future track for the platform in format (time, lat, long)	Low	Time step T (sec), Duration D (sec)
Great Circle Dead Reckoning	Position and Velocity	Lat/Long, Course, Speed(kts)		Given position and velocity data and time step and duration parameters, dead reckon the platform every T seconds for D seconds. Uses a great circle model for long distances.	Future track for the platform in format (time, lat, long)	Low	Time step T (sec), Duration D (sec)
Weighted Average	Set of numbers	Numeric		Computes the weighted average of the numbers.	Numeric	Low	Set of weights W
COA Score	COA, Criteria, and scores	Dictionary {criterion:score}		Passes scores to Weighted Average Fuselet, gets composite score.	[COA, Weighted Score]	Medium	Set of weights W
COA Recommendation	Set of scored COAs from COA Score Fuselet	List of [COA, Score] pairs		Ranks the COAs according to score.	Ranked list of COAs	Medium	
Rank	Set of numbers	Numeric		Ranks from largest to smallest	Set of numbers	Low	

Fuselet Name	Input Description	Input Format	Data Source	Functional Description	Output Format	Complexity Factor	Parameters
Cluster Analysis	Set of n-dimensional vectors	Vector		Identifies clusters in the inputs	Set of clusters	High	Percentile
Plume Prediction Service Wrapper	Wind velocity, incident location	Speed + direction, point coordinates	METOC data	Calls a plume model, returns plume as a contour.	Contour map.	High	
Targets With Collateral Damage Risk	Target location	Location	MIDB or open source (e.g. World Gazetteer KML)	Determines the targets that have associated collateral damage risks.	Set of targets with associated collateral risks.	High	Type restrictions, danger range.
Populated Areas Endangered	Event location	Location	Event prediction service stream, example: C2BMC impact point prediction, MIDB or open source (e.g. World Gazetteer KML)	Determines which populated areas are at risk from a significant event.	Set of endangered places.	High	Danger range.
Populace at risk	Set of populated places	List of place identifiers, population counts	MIDB or open source (e.g. World Gazetteer KML)	Aggregates populace from the places given	Numeric	Medium	
MGRS to Lat/Long	Location	MGRS coordinates		Converts location from MGRS to Lat/Long	Lat/Long	Medium	
MGRS to UTM	Location	MGRS coordinates		Converts location from MGRS to UTM	UTM coordinates	Medium	
UTM to MGRS	Location	UTM coordinates		Converts location from UTM to MGRS	MGRS coordinates	Medium	

Fuselet Name	Input Description	Input Format	Data Source	Functional Description	Output Format	Complexity Factor	Parameters
Lat/Long to UTM	Location	Lat/Long		Converts location from Lat/Long to UTM	UTM coordinates	Medium	
Lat/Long to MGRS	Location	Lat/Long		Converts location from Lat/Long to MGRS	MGRS coordinates	Medium	
Point In Area	Location, area description			Determines if a point is in the given area.	Binary	Low to High, depending on how complex the area description is.	
Imagery for Location Query	Location, Point in Area fuselet		Imagery metadata catalog	Retrieves imagery covering a specific location.	List of imagery products	High	
Surveillance Cover for Location	Location, Point in Area fuselet		Surveillance coverage web service	Determines surveillance assets providing coverage for a particular location.	List of surveillance assets	High	Surveillance type or spectrum
Target DB Query	Query criteria		MIDB or other domain object data base	Wraps a query against a target database.	List of targets	Medium to High, depending on query complexity	
Reconcile Nominated Targets	2 or more target descriptions		MIDB or other domain object database	Determines if two target descriptions refer to the same target.	Binary	Medium to High, depending on complexity of target descriptions	

Fuselet Name	Input Description	Input Format	Data Source	Functional Description	Output Format	Complexity Factor	Parameters
Merge TNLs	2 or more target nomination lists	Lists of target descriptions		Merges two or more target nomination lists.	List	High	
Develop Composite Priority for Target	2 or more target nomination lists	Lists of target descriptions		Arbitrates a priority for the target from several nominations.	Numeric	High	
Level at Location	Location and contour map	Location coordinates and contour descriptions		From a contour plot, determines level at the given location.	Numeric	High	
Nearest Location in a Given Direction	Origin, Location of interest set, Direction,	Coordinates, degrees		Determines the nearest location of the type or set given in the direction specified (within angular limits and a maximum distance) from the reference point.	Location	Medium	Angular offset, max distance
Flight Tracker	Flight tracks, area of interest	Coordinates	Flight tracker RSS, among others	Wraps a query for flight tracks in a specified area.	Set of flight tracks	High	Time window of interest.
Azimuth to Geostationary Satellite	Location, satellite parameters	Origin coordinates, footprint coordinates	Ephemeris	Determines the azimuth to the geostationary satellite.	Degrees	Medium	
Elevation to Geostationary Satellite	Location, satellite parameters	Origin coordinates, footprint coordinates	Ephemeris	Determines the azimuth to the geostationary satellite.	Degrees	Medium	

Fuselet Name	Input Description	Input Format	Data Source	Functional Description	Output Format	Complexity Factor	Parameters
Image Depth Conversion	Image, desired output bit depth	Image file, numeric		Converts the input image to an image with the specified bit depth.	Image file	Medium	
Image Size Conversion	Image, desired size	Image file, numeric		Converts the input image to an image with the specified size	Image file	Medium	

Table 3: Fuselet Descriptions

Appendix B. GS Fuselets Participation in WAITnC

B.1 Introduction

B.1.1 Background

A major objective of the Global Strike Fuselets (henceforth referred to as "GS Fuselets") effort is to elicit feedback from experienced military operators familiar with command and control during operations similar to Global Strike operations. To that end, the project plan called for a set of Limited Objective Experiments. For the second limited objective experiment the GS Fuselets contractor team participated in an event sponsored by the Global Cyberspace Integration Center (GCIC), designated as WARFIGHTER ANALYSIS OF INNOVATIVE CONCEPTS AND TECHNOLOGIES (WAITnC). The WAITnC event provided a good opportunity for operators to observe fuselet technology at work and to provide feedback. This report will present the results from the WAITnC event conducted from 17-21 September as focused on assessment of GS Fuselets.

B.1.2 Warfighter Analysis of Innovative Concepts and Technologies (WAITnC)

WAITnC was conceived as a smaller, higher frequency alternative to biennial Joint Expeditionary Force Experiment (JEFX) events. The focus of these JEFX events spans from modernization and sustainment C2 development efforts to research-focused events that explore innovative technologies and concepts. GCIC is defining the processes, roles and responsibilities for these events. WAITnC brings together a tailored matrix of Warfighters and technology providers. This event brought together U.S. Air Force Research Lab program managers, candidate technology providers, Transformation Center hosts, Global Cyber Innovation Center requirements and capability managers, selected warfighters, and TBC facilitators. This event was conducted at the U.S. Air Force Transformation Center, Langley AFB, VA. The event provided a venue for technology exploration, innovation, and discourse among stakeholders in order to optimize the value of research and development toward meeting the AOC WS Strategy Division warfighters' needs. Additionally GCIC/RICR will use the results of this event to aid in AOC requirements development.

The goal of the WAITnC is to provide early warfighter input directly to emerging technologies and technological concepts prior to initiation, during the spiral development and then for transition planning. WAITnC will be reoccurring innovation events where technologies and concepts will be reviewed by selected warfighters for their feedback. The technologies could range from fairly mature working prototypes (e.g. JAGUAR) concepts for new start technology efforts (e.g. Federated Strategy Development). WAITnC events will be run like a mini Futures War Game where all participating technologies and concepts will be aligned on the same basic scenario and the players will change roles as applicable. The events will usually start on a Monday afternoon and

finish by noon on Friday of the same week. A quick look out brief will be scheduled on Friday afternoon.

Battle Rhythm and Innovation Event Design

WAITnC employed a part-task, practicum methodology linked, to the maximum extent possible, by a common scenario and data structure. The unclassified PACIFICA scenario was used to structure mission threads and operational themes tailored to align with process activities and work flows commonly performed in the AOC Strategy Division. Each mission thread featured several technologies. GS Fuselets participated significantly in 2 threads and was discussed in the context of a third thread.

Assessment and Evaluation

WAITnC used a combination of structured participant observation and participant survey instruments to conduct assessment and evaluation. The technical evaluation team, comprised largely of AFRL/DARPA program managers and AOC Weapon System Integration (WSI) personnel, conducted participant observation. During each mission thread, the technical evaluator team recorded over-the-shoulder observations of participant activities in an unobtrusive manner. After each mission thread hotwash/discussion period, all participants completed a survey instrument evaluating each candidate advanced technology for time/man-hour efficiency, product quality effectiveness, and overall value added to the process workflow.

B.2 Results

B.2.1 Mission Thread Event #1

Operational Thread/Focus Theme: Mission Analysis / Building Common Situational Awareness

Principal Technologies: AECV, COA Sketch, SMART, GS Fuselets

Discussion: The joint force's mission is the task or set of tasks, together with the purpose, that clearly indicates the action to be taken and the reason for doing so. The primary purpose of mission analysis is to understand the problem and purpose of the operation and issue appropriate guidance to drive the rest of the planning process. Analyze the operational environment with respect to mission accomplishment. This analysis should result in understanding operational limitations and other considerations that affect execution and that bear on operational and strategic decisions. A comprehensive systems perspective considers the interaction between the individual elements of a system and across multiple systems (political, military, economic, social, informational, infrastructure, and others). The focus of this event is to use candidate technologies to build common situational awareness and understanding of the problem.

GS Fuselet Workflow: Target Extraction

In this operational thread we demonstrated how fuselets could be used to find targets meeting specific categorical and geographic criteria and display them on a map. The target extraction scenario is designed to provide commanders information about military forces, infrastructure, or other points of interest of a specific type within a defined lat-long bounding box. Parameters to the fuselet specify what type of units to display as well as the coordinates for the lat-long bounding box. The lat-long bounding box allows warfighters to further filter information to display specific regions of interest. A screenshot of the fictional scenario showing ground forces and prisons in the California Bay Area is shown respectively in Figures 1 and 2. Figure 2 also includes the map data showing terrain, cities, and highways that is included in the INTERACT collaboration client.

Ground Forces in Bay Area

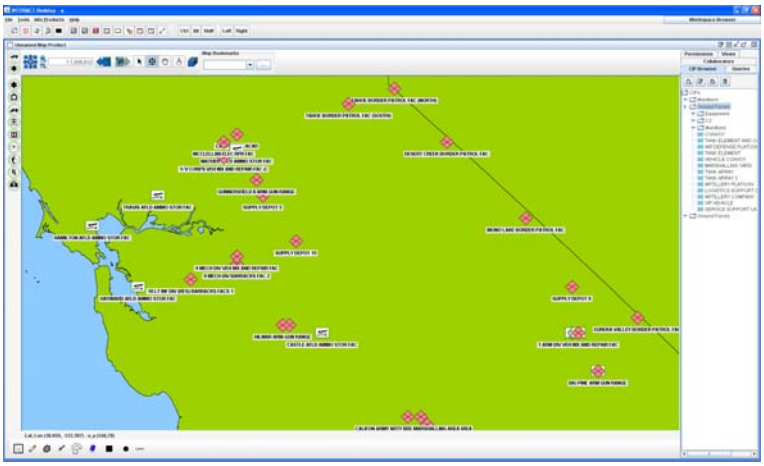

Figure 18: Fuselet Output of Ground Forces in the Bay Area

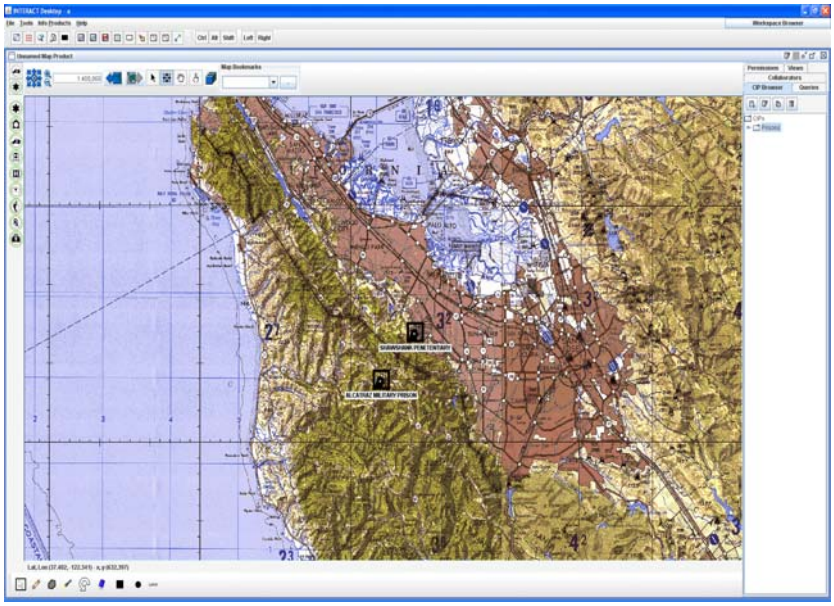

Figure 19: Fuselet Output of Prisons in the Bay Area

In this scenario and all subsequent scenarios, data was also entered into the INTERACT Database by a Google Earth KML reader fuselet. While the KML file contained all the relevant data, fuselets were used to organize and manage the data into pertinent information, organizing them into categories in which further processing could be performed to obtain the necessary knowledge.

GS Fuselets Survey Instrument Results

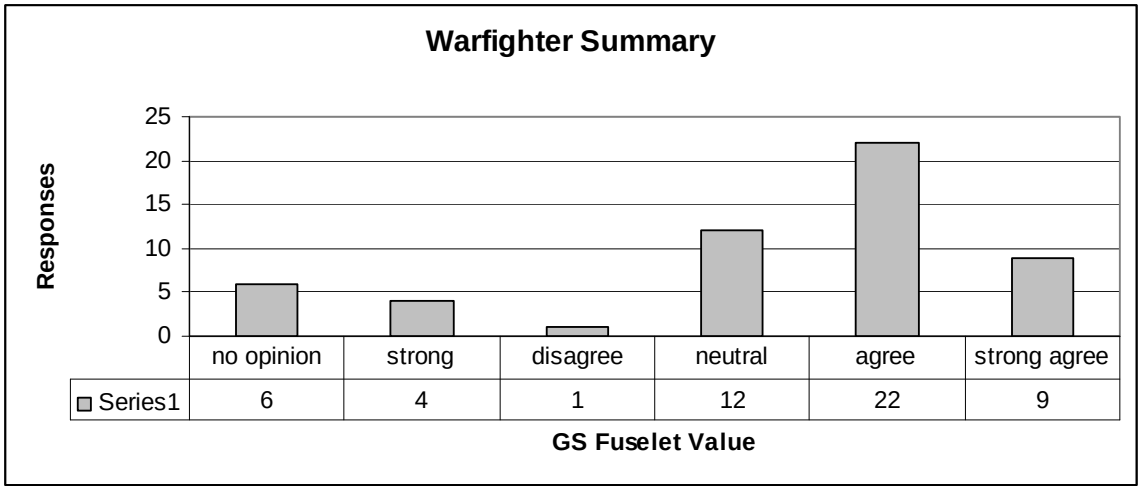

Figure 20: Warfighter Summary

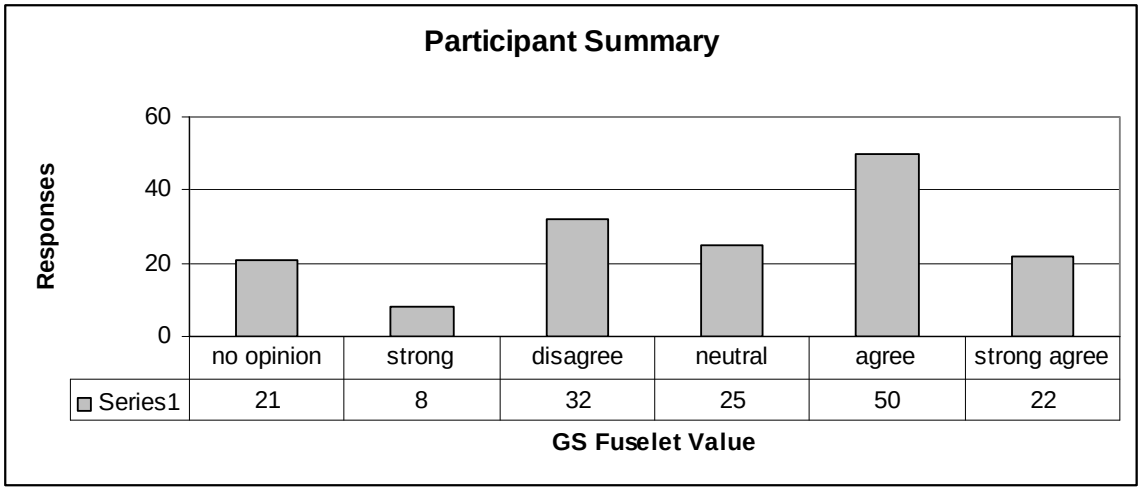

Figure 21: Participant Summary

Germane Participant Comments

- Useful for IPB and common SA building. Greater utility in later stages of planning and assessment.
- The fuselets themselves should be shared collaboratively so that the results are identical. Otherwise, a warehousing of results from an "official" set of fuselets should be accessible to prevent duplication of effort on the team and potential for different results based on differences in fuselet construction.
- Needs a SMART-like capability to be asked a question & have the tool parse the key words to automatically develop a draft fuselet(s)
- Great potential. I don't see much utility in actually determining CCIRs, but great utility in monitoring CCIRs and reporting related info available once those CCIRs are developed.
- As a Team/Division Chief, I must be able to do individual research, compile/view the research of my team members, maintain archives of various versions of that research, & share/export select info to a planning tool.
- Need to make sure that operators don't get too lazy using this. They still have to maintain as complete situational awareness as possible.
- Looks fairly easy to use. I like the idea of the software updating the target sets. Looks most useful at the tactical targeting/planning level.
- Can quickly map target sets and updates data automatically. It looks as though it can save time in these areas.
- Collaboration looks okay. It doesn't seem as intuitive as some of the other apps.
- Not sure how fuselet helps during planning stage.

Mission Thread Event #1 Assessment of GS Fuselets:

GS Fuselets offer significant potential to assist warfighters in mission analysis.

B.2.2 Mission Thread Event #2

Operational Thread/Focus Theme: Mission Analysis / Mission Statement and Commander's Intent

Principal Technologies: COA Sketch, PAL-MA, GS Fuselets

Discussion: The commander is the focal point of decision-making and execution during military operations. Commanders play a critical role in the planning process. Once given a mission, objective, and/or tasks in the higher headquarters plan or order, commanders form their initial situational understanding using their experience, judgment, and initial staff inputs. From this they develop an initial picture of the military end state and a construct for how to reach it. The mission statement should be a short sentence or paragraph that describes the organization's essential task (or tasks) and purpose — a clear statement of the action to be taken and the reason for doing so. The mission statement contains the elements of who, what, when, where, and why, but seldom specifies how. It forms the basis for planning and is included in the planning guidance, the planning directive, staff estimates, the commander's estimate, the CONOPS, and the completed plan. The commander's intent is a clear and concise expression of the purpose of the operation and the military end state. The focus of this event is to collaboratively develop a proposed JFACC mission statement, intent, proposed CCIRs and deliver a decision brief to JFACC for approval and direction to continue planning.

GS Fuselet Workflows Demonstrated in This Thread

In this mission thread we demonstrated two fuselet workflows. One workflow was used to obtain weather data of interest to the commander and overlay it on the operational context, be it Blue resource planning or targeting activities. The second workflow was similar to the workflow in the first mission thread in that it discovered no-strike and restricted targets in the proximity of a key target of interest.

Workflow: Airfield Site Weather and Restrictions

The Airfield and Weapons of Mass Destruction (WMD) Site Weather Scenario illustrates the real-time data processing capabilities of fuselets. In this scenario, a fuselet subscribes to Yahoo Weather RSS feeds and adds wind velocity, wind direction, and visibility data to each airfield and WMD site's information object based on their precise locations. Separate fuselets for airfield and WMD sites process each instance of that type and based on a set of parameters, produces a list of instances that meet all the criteria listed. For example, a military commander wants to know all the airfields available with a wind velocity of greater than 20 knots, which would not allow military aircraft to safely take off and land at that location and perform their mission. The military commander also needs information about weather conditions at WMD sites for the purposes of meeting visual identification requirements and for estimating the potential spread of any fallout. A low visibility may preclude attack under the rules of engagement in place and requirements for positive identification. Displaying wind direction can help the commander determine if populated areas are at risk of contamination. Fuselets are able to instantly provide this information and produce a list in either map or table format. Figure

3 illustrates a table that was produced by an airfield weather fuselet showing all airfields in Nevada with a wind velocity greater than 20 knots, quickly eliminating them as options for locations to support missions.

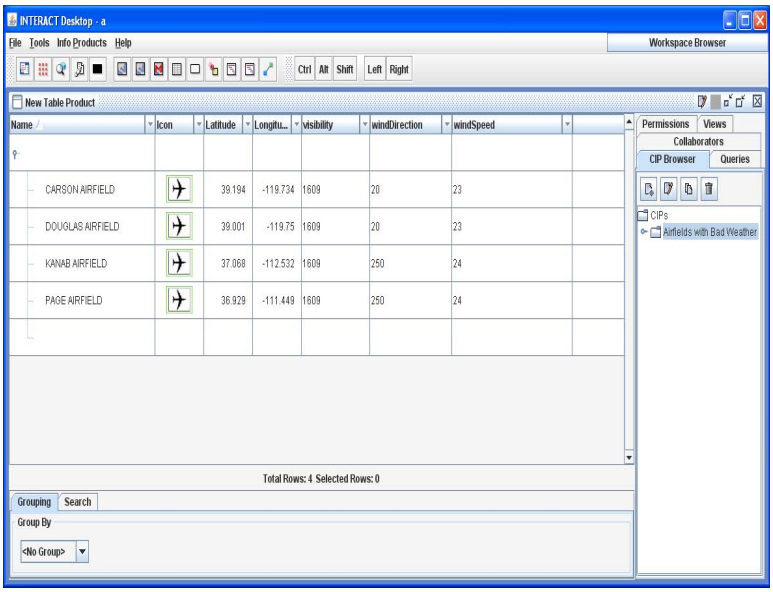

Figure 22: Fuselet Output Showing Airfields with Weather Restrictions

This capability is critical to the military commander because it highlights potential problems with his plan and shows employment constraints on his resources. The fuselets in this example were configured to update the weather information every five minutes, providing near real-time information to the warfighters. Up-to-date information is critical to the success of modern military operations. Furthermore, the workflow can be quickly adjusted to pull weather data from an alternate source if the first source is not available.

Workflow: Collateral Damage/No Strike Locations

The collateral damage/no strike locations scenario illustrates the potential collateral damage than can occur from a military strike. Presenting that information to a military commander allows actions to be taken to minimize the loss of civilian life as well as damage to churches, hospitals, cemeteries, and other civilian infrastructure. It also helps the commander ensure his operations comply with the rules of engagement.

The fuselet workflow begins when the military commander identifies a target to attack. As in previous examples, a fuselet uses a location to query the INTERACT database for objects of a particular type within a specified range. The user can also specify which no-strike target types to process. For example, the commander may not care if libraries are possibly damaged but wants to avoid damage to religious institutions at all costs because of the political fallout that may occur. The commander will then specify the fuselet to only consider religious institutions when no-strike locations are processed for collateral damage implications. Figure 4 illustrates a visualization of the

scenario just described in which the Santa Clara Nuclear Weapons Facility is attacked, showing a library, three hospitals, and two churches as possible collateral damage.

Collateral Damage Locations for Santa Clara Nuclear Weapons Facility

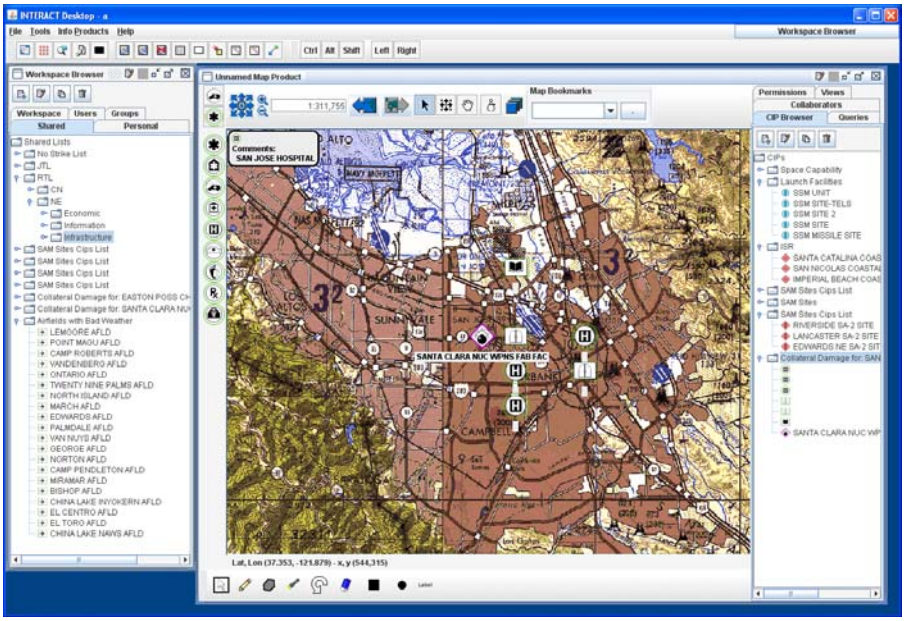

Figure 23: Fuselet Output - Collateral Damage Warnings

GS Fuselets Survey Instrument Results

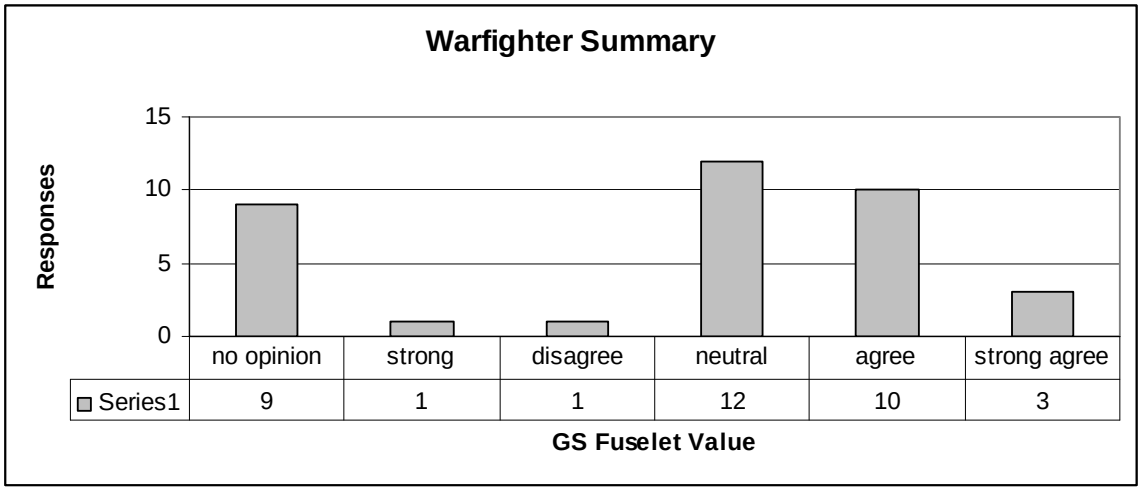

Figure 24: Warfighter Summary

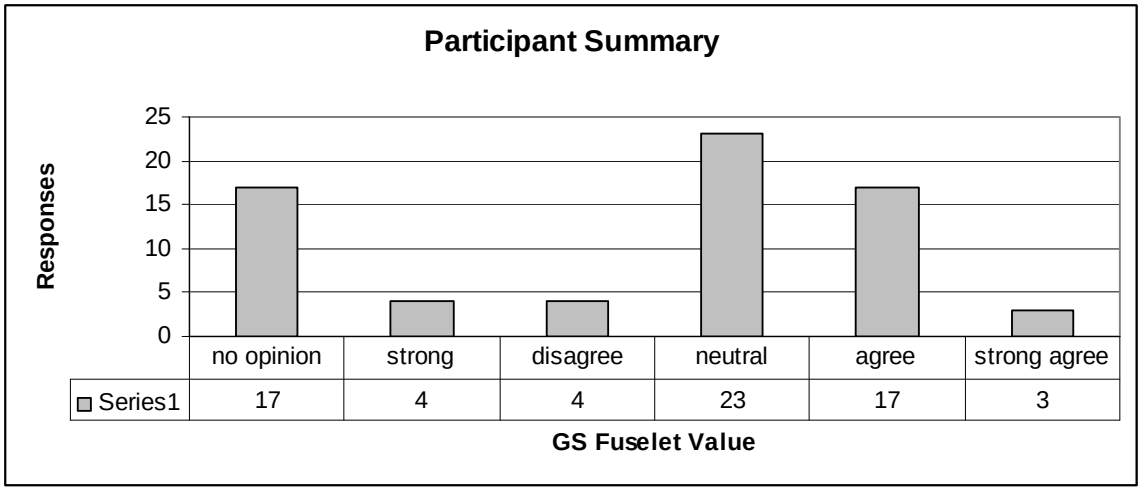

Figure 25: Participant Summary

Germane Participant Comments

- Difficulty in generating mission statement comes from getting JFC mission statement and end state. Technology not really needed - long pole is staff interaction, not cognitive load. Fuselets useful for getting beddown, enemy force info when discussing mission analysis.
- The value of this technology should be assessed independent of the EBAO construct. It supports EBAO but is not limited to the concept.
- Implementation will impact the answer to this question. If fuselets are federated and synchronized so there is only one answer, workflow will improve. If each user builds their own fuselets and later passes along the results, workflow would be hindered as results would require an accompanying definitions document to understand what the results actually were.
- Substantial time savings with dynamic refreshing of fuselet results. Downside is significant investment in initial setup cost and the need to manage the fuselets to ensure there are no conflicting requests.
- This technology supports collaboration and can provide valuable info in the absence of OPRs for desired info. Fuselets should NOT be used in lieu of collaboration as the user may miss valuable insight from the perspective of a contributing office.
- Looks like this has a lot of potential to inform
- I see little utility in initial planning, but an awesome monitoring capability during execution for all AOC divisions & teams.
- Great potential to feed data on force status, JOA environment, daily changes, Intel feeds.
- Again, potential to speed the dissemination of information
- Same comment as above - great potential in collaboration.
- This technology would also be useful to the logistics' community for bed-down of forces as well as the Master Air Attack Planners (in the AOC Combat Plans Division). Can use criteria to pick or not pick assets. Also, a good application for

execution (weather for pred missions), WMD strike use: query the RTL for positions near the proposed kinetic target. Actual weather data can be fused into the decision making process**.**

- This technology will allow us to tag effects' criteria indicators either during or after plan development.
- This tool is not as useful for mission statement development as it could be for tactical planning/targeting. I would like to see it integrated with Telescope to automatically update the status of links/nodes as BDA is updated. This would save huge amounts of time and coordination with the A2.
- I see little utility in initial planning, but an awesome monitoring capability during execution for all AOC divisions & teams (wx impacts, logistics status, CCIR, PIR, FFIR, etc)
- Could prove useful for gaining a situational awareness, but would be more appropriate for a tactical planning tool.
- Liked simple/clean admin user interface to add fuselets
- Would like to see end-user interface to create fuselets in integrated tools (such as defining a range on a map and selecting the type of weapon system to get information for, which would create new notes within a SMART notebook which would refresh whenever new data became available, in a way tie agent(FUSELETS) based research to user-directed based research(SMART))
- Would like FUSELETS notes within the SMART notebooks (which would gather the latest information and list it within the SMART notebook.
- Would like the concept of FUSELETS (little business processes) to be used as to gather information from disparate data sources through the SMART Active NLP interface (mapped question types derived from NLP analysis to business processes to solve to collect, massage the data to knowledge)

Mission Thread Event #2 Assessment

GS Fuselets offers significant potential to assist warfighters in mission analysis

B.2.3 MISSION THREAD EVENT #3

Operational Thread/Focus Theme: Course of Action Development

Principal Technologies: COA Sketch, IFOTA, XGEN, SAAP, SMART, DCOAD

Discussion: A COA consists of the following information: what type of military action will occur; why the action is required (purpose); who will take the action; when the action will begin; where the action will occur; and how the action will occur (method of employment of forces). The staff converts the approved COA into a JAOP. The focus of this event is to employ candidate technologies to produce COAs characterized by ends, ways, means, and risk.

GS Fuselet Workflows Demonstrated in This Thread

No fuselet workflows were demonstrated in this thread. There were some operator comments on applicability of fuselets to this thread, perhaps because an earlier agenda had GS Fuselets participating in it. The results below are included for the sake of completeness.

GS Fuselets Survey Instrument Results

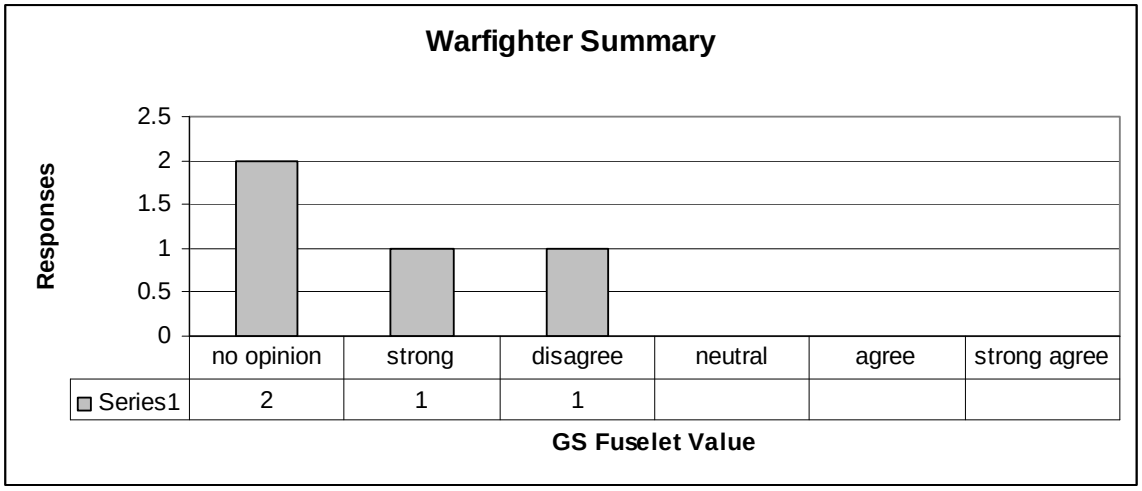

Figure 26: Warfighter Summary

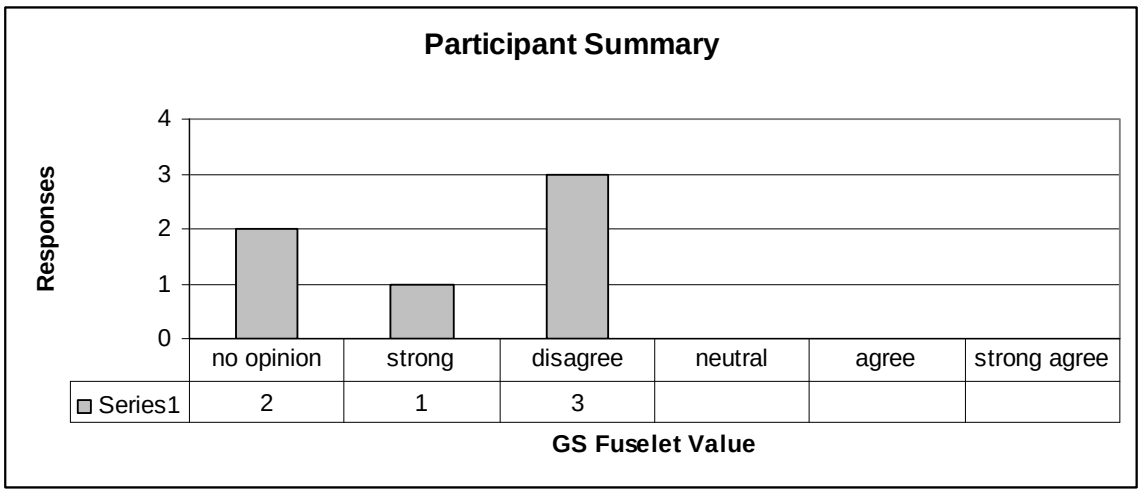

Figure 27: Warfighter Summary

Germane Participant Comments

- Seems more valuable during execution phase instead of planning phase

Assessment

GS Fuselet contribution to Course of Action planning is yet to be matured.

B.3 Conclusions

B.3.1 Summary

In the threads where we developed and demonstrated fuselet workflows (Mission Thread Events #1 and #2) many more warfighters and participants agreed with the proposition that fuselets add value to the thread than disagreed. Among responders who expressed an opinion, the breakdown of responses was as follows:

Thread	Responder Group Expressing an Opinion	Agree or Strongly Agree	Neutral	Disagree or Strongly Disagree
#1	Warfighters (48)	64.6%	25.0%	10.4%
#1	Participants (137)	52.6%	18.2%	29.2%
#2	Warfighters (27)	48.1%	44.4%	7.4%
#2	Participants (51)	39.2%	45.1%	15.7%

Table 4: Response Summary

This is encouraging for the prospects of fuselet technologies providing benefit to AOC Strategy Division operations. For example, consider the warfighter responses in thread #1. If 64.6% of the responses indicate value added by fuselet technology based on demonstration of a small set of specific fuselet workflows then the potential level of support for the fuselet value proposition should be at least this high, if not higher.

B.3.2 Acknowledgements

Mike Pinter of Teledyne Brown CollaborX (TBC) compiled the majority of this report. Mike and TBC were instrumental in organizing the entire WAITnC effort for the Global Cyberspace Integration Center (GCIC) and in collecting the data from the participants.